

CASE STUDIES IN DOWNSIZING

INPUT

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Case Studies in Downsizing

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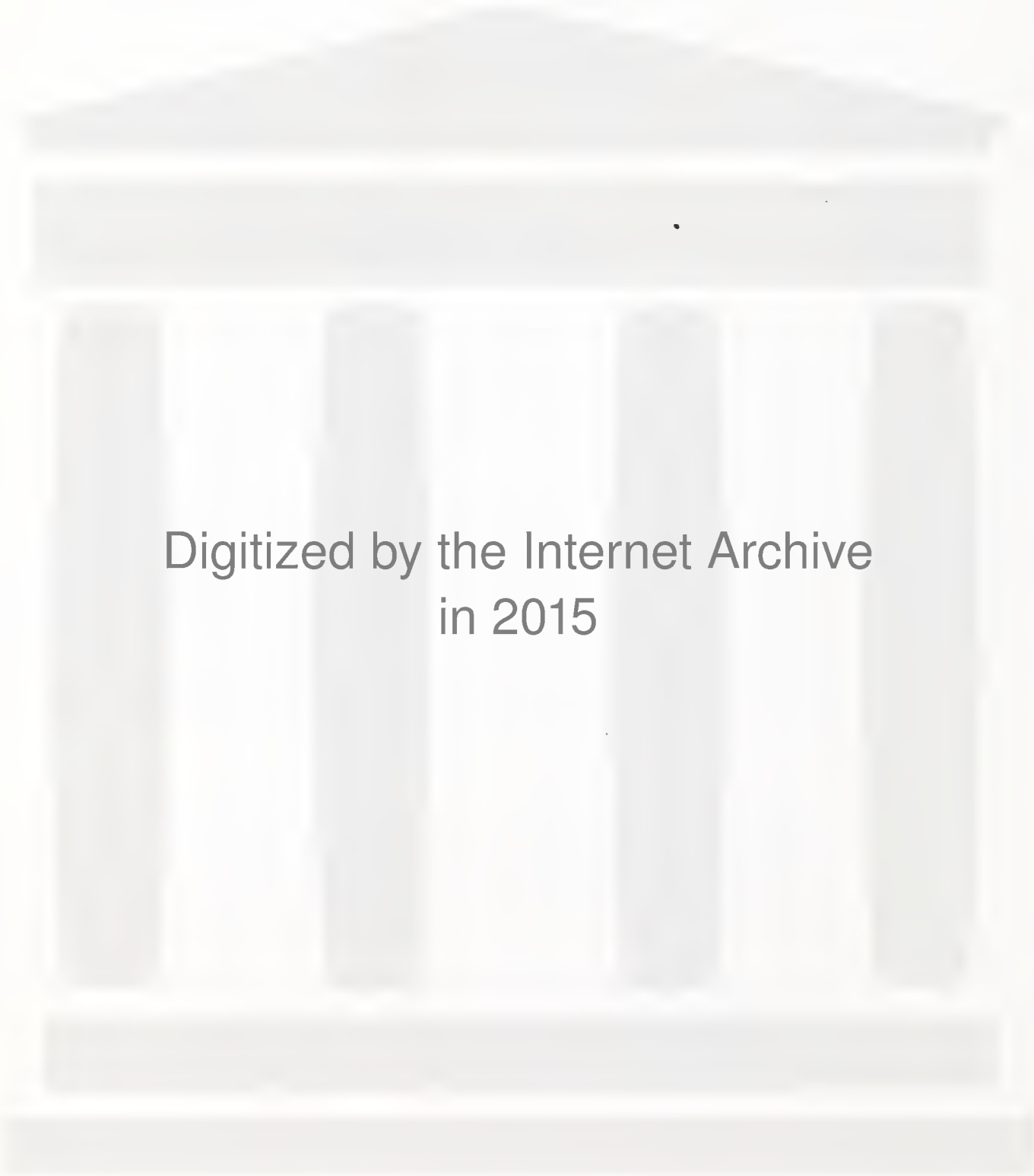
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Abstract

Case Studies in Downsizing is the third in a series of issue reports published by INPUT that examine current downsizing trends. It presents, in depth, the cases of five organizations that have already downsized or are currently doing so. The report also discusses several downsizing efforts that have been published in the trade press. The purpose of this report is to explore, by offering real-world examples, the reasons for and effects of downsizing in a variety of institutions. Is downsizing something all companies should consider? Is it the right approach for everyone? Are companies that are downsizing achieving the benefits they expected? When is the right time and what are the appropriate conditions for downsizing? Are most efforts successful? These are the types of questions many organizations are asking. The case studies presented in this report are intended to help answer such questions.

The types of organizations included—in both the in-depth and review sections—are diverse. The range spans a major university, a railroad, a minicomputer company, a utility, a large furniture chain, and a county government, to name a few. From this broad spectrum of cases, and careful examination of the problems and successes of their downsizing endeavors, INPUT hopes to clarify matters for companies in search of a downsizing solution.

The report contains 132 pages, 23 exhibits, and a bibliography.



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Table of Contents

I	Introduction	I-1
	A. Objectives	I-3
	B. Methodology and Scope	I-4
	1. Methodology	I-4
	2. Scope	I-4
	C. Report Structure	I-5
II	Executive Overview	II-1
	A. Summary of Strategic Case Studies	II-2
	1. Case Study #1	II-2
	2. Case Study #2	II-2
	3. Case Study #3	II-3
	4. Case Study #4	II-5
	5. Case Study #5	II-6
	B. Summary of Published Case Studies	II-7
	C. General Conclusions	II-9
III	Review of Previous Research	III-1
	A. An "Upsizing" Case Study	III-1
	1. Cost Comparison—Centralization versus Decentralization	III-1
	2. Keeping the Mainframe Busy	III-5
	3. Target Selection	III-7
	B. Putting Downsizing in Perspective	III-8
	1. Platform Report Card	III-8
	2. Factors Prompting Downsizing	III-10
	3. Factors Inhibiting Downsizing	III-12
	C. Systems Architectures for Downsizing	III-13
	1. Behind the Screen	III-14
	2. At the Screen	III-16
	3. Beyond the Screen	III-17

Table of Contents (Continued)

IV

Strategic Case Studies	IV-1
A. Case Study #1—Modeling Costs in the Downsizing Environment	IV-3
1. Background	IV-3
a. Factors Prompting Downsizing	IV-4
b. Factors Inhibiting Downsizing	IV-4
c. Applications	IV-5
d. Platform and Architecture Selection	IV-5
e. Cost Justification	IV-6
2. Implementation	IV-6
3. The Cost and Funding Task Force	IV-6
a. Purpose of the Task Force	IV-6
b. Assumptions	IV-7
c. The Cost Model	IV-8
d. Recommended Strategies	IV-14
B. Case Study #2—Rightsizing the Information Architecture	IV-15
1. Background	IV-15
2. The Mainframe Trap	IV-16
a. Systems Software Is No Longer “Free”	IV-17
b. The Nature of the Trap	IV-18
3. Information Architecture and Data Quality	IV-19
a. Early Data Processing—Centralized	IV-20
b. Downsizing Data Entry with “Terminal Typewriters”	IV-21
c. Early Image Processing and Recentralization of Data Entry	IV-22
d. Downsizing with Distributed Processing	IV-22
e. Personal Computers Appear	IV-23
f. Downsizing, Upsizing and Rightsizing	IV-24
g. The Human Side of Downsizing and Empowerment	IV-25
4. Function and Application Selection for Downsizing	IV-26
a. Data, Data Everywhere and Still No Solution	IV-26
b. Experience Has No Substitute	IV-27
5. Downsizing Results	IV-28
6. The Downsizing Cost Model	IV-29
a. The Data Center	IV-29
b. Network Services	IV-31
c. Application Custodian	IV-32
d. End User	IV-33
C. Case Study # 3—Proprietary versus Open Systems	IV-34
1. Background	IV-34
2. The Downsizing Plan	IV-36

Table of Contents (Continued)

IV

3.	The Issue—Open versus Proprietary Systems	IV-36
4.	The Downsizing Cost Model	IV-37
a.	Data Center	IV-39
b.	Network Services	IV-39
c.	Application Custodian	IV-40
d.	End User	IV-42
D.	Case Study #4—Downsizing and the Fight for Survival	IV-43
1.	Background	IV-43
2.	The Current Network Architecture	IV-44
3.	Downsizing, Open Systems and Survival	IV-45
a.	Factors Prompting Downsizing and Open Systems	IV-45
b.	Factors Inhibiting Downsizing	IV-45
c.	Application Selection for Downsizing	IV-46
4.	The Downsizing Cost Model	IV-46
a.	Data Center	IV-47
b.	Application Custodian	IV-49
c.	End User	IV-50
E.	Case Study #5—Actual Transition to a Downsized Environment	IV-52
1.	Background	IV-52
a.	Factors Prompting Downsizing	IV-52
b.	Factors Inhibiting Downsizing	IV-52
2.	Transition to Downsizing	IV-53
a.	Important Decisions	IV-53
b.	Re-engineering During Downsizing	IV-54
3.	The Cost Model	IV-54
a.	Data Center	IV-55
b.	Network Services	IV-57
c.	Application Custodian	IV-57
d.	End User	IV-58

V

	Published Case Studies	V-1
A.	The Original Case Studies	V-1
1.	Downsizing Corporate IS	V-2
2.	Downsizing Mainframes	V-2
3.	Cost Benefits of Downsizing	V-8

VI

	Analysis of Case Studies	VI-1
A.	Factors Prompting Downsizing	VI-1
B.	Factors Inhibiting Downsizing	VI-3

Table of Contents (Continued)

VI

C. Architecture and Applications Selection	VI-4
1. SAA and Downsizing	VI-4
2. Application and Data Placement	VI-6
a. Managing Price/Performance in a Client/Server Environment	VI-7
b. Centralization versus Decentralization of Function	VI-8
c. Predicting Performance	VI-9
D. The Transition Trap	VI-10
E. Downsizing and Staffing	VI-12

VII

Conclusions and Recommendations	VII-1
A. Conclusions	VII-1
B. Recommendations	VII-5

Appendix

A. Case Study References	A-1
---------------------------------	------------

Exhibits

II

-1	System Targeted for Downsizing—Replacement Status	II-7
-2	Downsizing Platforms—Replacement Status	II-8
-3	Benefits Mentioned	II-9
-4	Architecture and Application Selection	II-10

III

-1	Decentralized versus Centralized Expense	III-2
-2	Cost Comparison versus Standalone (by node)	III-4
-3	Hardware Platform Report Card—IS Management	III-9
-4	Factors Prompting Downsizing	III-11
-5	Factors Inhibiting Downsizing	III-12
-6	Downsizing Issues	III-14

IV

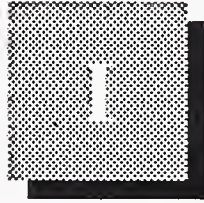
-1	Downsizing Cost Factors	IV-8
-2	A Changing Information Architecture	IV-20
-3	Case Study #2—Downsizing Cost Factors—Client/Server versus Mainframe	IV-30
-4	Case Study #3—Downsizing Cost Factors—AS/400 versus Mainframe and UNIX	IV-38
-5	Case Study #4—Downsizing Cost Factors—Client/Server versus Current	IV-48
-6	Case Study #5—Downsizing Cost Factors—Client/Server versus Mainframe	IV-55

V

-1	Downsizing Case Studies	V-3
-2	Systems Targeted for Downsizing—Replacement Status	V-5
-3	Downsizing Platforms—Replacement Status	V-6
-4	Benefits Mentioned	V-8

VI

-1	Replacement Vulnerability	VI-2
-2	Architecture and Application Selection—SAA and Downsizing	VI-5
-3	The Transition Trap	VI-11



Introduction

INPUT has been concerned about the economics of computer-communications networks since the company was formed over 15 years ago. In the mid-1970s, INPUT conducted extensive research that verified classic economy of scale within the IBM product line, and clearly demonstrated the advantages of replacing standalone systems with a hierarchical network based on large, host mainframes. It was determined that these large mainframes replaced more standalone systems than was indicated by simple price/performance ratios, and INPUT published tables of “replacement ratios” to guide clients who wanted to take advantage of the “new hardware economics.”

In addition, it became apparent that reduced hardware expense was only one of numerous benefits of large data centers. The arguments for (and economics of) consolidation of processing, data and human resources at that time were compelling; and many of them were independent of hardware price/performance. However, INPUT was fully aware that both minicomputers and microprocessor-based “intelligent terminals” were on much steeper price/performance curves than were mainframes. For that reason, INPUT recommended a strategy of consolidation followed by the “orderly distribution of processing” back to user departments.

At the beginning of INPUT’s research on downsizing, it was apparent that the diffusion of microprocessor-based technology during the 1980s was not an orderly process, and that downsizing was being promoted as an extension of the personal computer “revolution” with little regard for proper network structure. The myopic focus on MIPS seemed to ignore both the benefits of centralization and the potential problems of downsizing.

INPUT’s initial research on downsizing tended to confirm that downsizing was being pursued without full understanding of the potential consequences. Specifically:

- The primary motivation for downsizing was found to be the reduction of IS and hardware costs, but those who had completed downsizing efforts (or who were about to complete them) no longer listed cost savings as being a primary anticipated benefit.
- Published industry case studies of completed projects also waved some red flags about the economics of downsizing efforts. For example, one company broke up the central IS function and then found that it had to hire a comparable number of IS personnel at the network nodes, and these employees were more expensive because higher level skills were required in the downsizing environment.
- Technological downsizing is being accompanied by management downsizing (specifically, reduction in levels of middle management), which probably will require more (rather than less) investment in information technology.
- The complexity of emerging networks of systems will be greater than the centralized systems being replaced, and this will require more (not fewer) professional systems personnel. This fact is being ignored by those who propose “bottom-up system development,” which emphasizes turning over systems development responsibilities to casual end users.
- In addition, the advocates of bottom-up system development have adopted a client/server architecture based on the assumption that a source of high-quality data will be available somewhere in the organization, and that the potential problems of distributed data base management will be magically solved as downsizing proceeds.
- Finally, the published literature on downsizing shows that there is a lot of cream-skimming going on in current downsizing efforts. Relatively simple applications and functions are being downsized, and all of the complexity is being left up to the central IS organization. While there isn't anything inherently wrong with cream-skimming, there is substantial risk that the central data center will be exposed to declining “income” with little possibility of reduced expenses.

INPUT feels it is important to understand the real economics of computer-communications networks in order to make effective use of new information technology. This requires identification and analysis of the cost factors related to downsizing. INPUT believes this can only be accomplished by drawing on the knowledge of those who are developing comprehensive, long-range plans for downsizing current networks. Therefore, INPUT has carefully selected five organizations for in-depth cases studies.

A

Objectives

This report has the following objectives:

- To review briefly the economics of centralization and “upsizing” in order to identify benefits that may be overlooked, and perhaps negated, by indiscriminate downsizing
- To analyze the complex, and sometimes conflicting, motives and anticipated benefits of downsizing
- To separate networking knowledge and experience from the information, propaganda and hype that have become attached to downsizing
- To identify the benefits and problems that knowledgeable people anticipate from downsizing
- To determine how innovative information technology will be managed in the 1990s
- To review the current state of planning for the distribution of processing power and data to the technological and organizational hierarchies
- To determine the anticipated redistribution of responsibilities for the development and maintenance of information systems resources (including data) as downsizing proceeds
- To identify and analyze the various cost factors associated with downsizing
- To provide a general framework for cost/benefit analysis of downsizing
- To summarize and synthesize the experience and knowledge gained from the case study organizations
- To make recommendations based upon the synthesis of this experience and knowledge

B**Methodology and Scope****1. Methodology**

INPUT has already conducted comprehensive research on downsizing in order to put it into perspective. The data obtained from that research has been analyzed from an architectural point of view. Based on this research and analysis, INPUT identified certain issues, reached some conclusions, and made recommendations. In order to check the credibility of INPUT's analysis, and extend the research to a more detailed level, five organizations were selected for in-depth strategic analysis.

These organizations have not been selected randomly. They have been carefully selected based on the experience and knowledge of their IS executives. Specifically, INPUT selected organizations (and executives) that have experienced cycles of centralization and decentralization, and have had the opportunity (and challenge) of developing and managing networks of systems in both highly centralized and distributed environments. Most of these organizations have been the subject of detailed INPUT research in the past. This knowledge base provides the foundation for putting their current downsizing innovations into proper perspective. In addition, special attention was given to selecting diverse organizational cultures, because it is INPUT's belief that the success of both technological and management downsizing efforts will be heavily dependent upon changes in mindset and organizational culture.

The current research employed multiple personal and telephone interviews with the case study companies. These interviews were designed to obtain information concerning the issues outlined above. The focus of the interviews was on the organizations' strategic plans for both technological and management downsizing with emphasis upon cost/benefit analysis. Approximately thirty-five separate interviewing sessions were conducted.

In addition, an analysis was made of published case studies over a three-month period. The purpose was to identify actual replacement patterns for various platforms and the benefits anticipated or actually achieved.

2. Scope

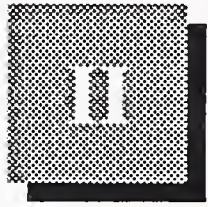
The scope of this study is sufficient to provide a general cost/benefit framework for planning technological downsizing efforts, and provide "red flags" for many anticipated problem areas. It also provides a set of diverse cultural models that can serve as points of reference in putting management downsizing into perspective. This study makes no pretense of providing a "cookbook" solution for either technological or management downsizing, but it should be a useful document for planning purposes.

C

Report Structure

A brief description of the report is as follows:

- Chapter II, Executive Overview, provides a brief summary of the issues as seen by the case study organizations, and INPUT's conclusions and recommendations concerning cost/benefit analysis of downsizing.
- Chapter III, Review of Previous Research, provides a succinct review of INPUT's previous downsizing research, and defines the major issues that have been identified.
- Chapter IV, Strategic Case Studies, will present each case study in the following format:
 - Background of the factors prompting downsizing, application selection, architecture selection and cost justification
 - Implementation plans in terms of organization, project management and support
 - The quantitative and qualitative results achieved or anticipated for downsizing in the following areas:
 - Application Support
 - Hardware
 - Systems Support
 - Staffing
 - Transition Costs
 - The benefits and/or consequences that have been achieved and/or are anticipated from the downsizing effort
- Chapter V, Published Case Studies, will analyze the results anticipated or actually achieved in published case studies.
- Chapter VI, Analysis of Case Studies, will analyze the results of the research in the case study format presented above.
- Chapter VII, Conclusions and Recommendations, will summarize INPUT's conclusions and recommendations concerning downsizing, with emphasis on the development of a downsizing strategy.



Executive Overview

Downsizing is a media event—a modern day, technological version of David’s challenge to Goliath played out and reported at many levels. Little microprocessors will replace mighty mainframes with enormous savings in hardware costs. A simple “open” operating system will replace complex proprietary systems. Cheap shrink-wrapped software purchased off the shelf will make massive internal development efforts unnecessary. End users employing new methodologies and tools will eliminate the need for the big IS department with its systems analysts and programmers. A few executives, armed with new information technology, will slay corporate bureaucracy and reign supreme over leaner, meaner organizations *sans* layers of unnecessary middle management. And relatively small, upstart companies will finally bring IBM to its knees even as it tries to become leaner and meaner itself.

That is how the story goes, and both the media and corporate executives want to believe that it is true. The media is merely supporting its advertisers with “news,” but corporate executives need technological downsizing to support their own organizational downsizing initiatives.

IS management, for obvious reasons, isn’t very enthusiastic about some of the ramifications of downsizing. While the media reports the demise of CIOs who have “worked themselves out of a job,” those who remain are confronted with major challenges in achieving the anticipated benefits of downsizing after having been clearly identified as being part of the problem. IS management, in turn, has identified IBM as part of its problem for the following reasons:

- After years of following IBM leadership because this route was “safe,” it has been found to lead to a mainframe trap—a position that is indefensible in terms of cost and complexity.
- IBM’s plan for getting out of the mainframe trap (SAA) has not been implemented in a timely manner, appears to lack definition and support within IBM, and has only contributed to the current confusion concerning downsizing.

- Essentially, customers have lost confidence in IBM's ability to "make it work," and the result is loss of account control.

A

Summary of Strategic Case Studies

1. Case Study #1

Case study #1 is a major university that has been on the leading edge in the application of information technology. It is now trying to define a long-range information architecture based on downsizing and client/server architecture. One of the primary cost justifications is that "off-the-shelf" software (including systems software) will be substituted for in-house development and maintenance.

When asked about the analysis underlying the decision to pursue a new information architecture, it was stated that it was "based mostly on what people read in the trade press." However, part of the planning process involved the establishment of a "Cost and Funding Task Force," which developed the comprehensive cost matrix that has been employed in this study. Tentative conclusions are:

- There will be at least two more major upgrades before mainframe growth can be contained.
- Some of the cost/benefit assumptions, such as the cost benefits associated with off-the-shelf software, are being questioned.
- While it is possible to come up with reasonably good estimates of whether certain cells in the cost matrix will increase or decrease, the net impact is difficult to determine.
- It has already been concluded that the transition costs for specific applications could never be recovered, and no effort will be made to convert such applications unless there is a good business reason.
- The suspicion is that the net effect will be additional investment in information technology. Although this is not considered necessarily bad, it is suspected that this is not what management has in mind—especially in the short term.

2. Case Study #2

Case Study #2 is a major railroad that has done everything "right," but still finds itself in a mainframe trap.

- At one point, it developed all of its own software (including systems software), but it then opted for vendor-provided software because it was “free.” It now spends \$3 million on outside software, and management is wondering how it ever got itself in its current position.
- It adopted COBOL early when it was supposed to provide ease of use, self-documentation, and portability across various vendor platforms. The company was confident that COBOL would remain the common business language because the government was forcing all vendors to support COBOL. It now finds itself with a thirty-year investment in COBOL programming that is a most serious impediment to downsizing and “open systems.”
- It distributed processing in the 1970s, and installed a large minicomputer network, only to find that its mainframe installation continued to grow.
- It has been a pioneer in computer-communication networks, but has been forced to go through repeated cycles of centralization and decentralization in its attempts to maintain data quality.
- One application that has been downsized to RISC workstations is the distribution of railroad rolling stock. However, the supporting data remains on the mainframe, and despite years of applying the latest techniques of both operations research and artificial intelligence, it still isn’t “one of our better applications.” Cheap processing power alone doesn’t always solve problems.

The railroad has literally done many things right over the years, and it has remained on the leading edge in the effective application of information technology. The number of employees on the railroad has been reduced substantially in the last ten years through the use of information technology. Today, an image processing system is being installed that will lead to the downsizing of the company’s minicomputer network and the eventual downsizing of its mainframe computers. It is an ambitious plan.

However, management still wants to know how it got trapped without an alternate source of supply for systems software, and a member of the board of directors has explained that his company has already downsized with good results. IS management faces a continuing battle as it tries to rightsize the computer network and still maintain credibility with corporate management, which “just doesn’t understand.” It is all so simple in the business magazines.

3. Case Study #3

Case Study #3 is an international energy company that generally avoided the mainframe trap by installing an extensive international network of System/3Xs, and now AS/400s. Systems personnel at the company are convinced that the AS/400 is the best distributed data base server in the

industry, and they all state that they would never be willing to go back to the mainframe environment. So when it was time to downsize a 3090 mainframe inherited from a joint business venture, the course of action seemed clear: downsize to an AS/400, right?

Wrong! When the transition plan was submitted, the estimate for the downsizing effort was approximately \$4 million, including hardware, communications, and applications conversion. Someone in corporate management decided it was an appropriate time to consider the benefits of open systems. Why not convert to a UNIX open system so that eventually all 60 AS/400s would also be replaced? Then the company would be free to pursue the joys of open systems and install any computer anywhere and have them all work together in perfect harmony on into eternity—with MIPS to spare.

This stopped the downsizing project dead in its tracks. What an idea! Why hadn't the downsizing conversion team thought of that? It isn't the downsizing that is important, it is getting out of the clutches of those proprietary operating systems vendors. All of the open systems vendors lined up solidly behind any plan to replace 60 AS/400s—even IBM with its RS/6000.

IBM really hadn't been selling the AS/400s anyhow—the company had been buying them and installing them. And, over the years, it raised all kinds of embarrassing questions about IBM's networking support. The company's network ran without the “benefit” of a mainframe to run the whole show, and IBM found this difficult to comprehend; it thought everyone had been caught in the SNA trap.

INPUT interviewed this company just as it was beginning its analysis of UNIX-based systems versus the AS/400. Among the issues identified were:

- The cost of converting a \$15 billion investment in AS/400 software development that “works”
- The cost of selecting and installing systems software (including a DBMS and security) necessary to bring UNIX up to the level of OS/400
- Determining how “open” a UNIX system really is once the data base decision has been reached
- The cost of retraining AS/400 systems personnel in UNIX and C, which is considered to be a big step backward in terms of ease of use
- The problems of retaining systems personnel skilled in the AS/400 who wouldn't want to move to the UNIX world

The leader of the downsizing conversion group concluded that it would be “disastrous” to replace the AS/400 network because “we just don’t remember what it used to be like.” However, the scientific side of the company feels that the commercial data processing can be run as an appendage of the engineering department, which is primarily concerned with oil exploration.

The jury is still out on exactly what to do about the downsizing effort. It is possible it will just be delayed. The hardware is written off, but the continuing software expense was described as “killing us.” There is currently a rumor that the IS department could be cut in half if the company went to open systems. Needless to say, this is not the opinion of the IS department, which feels that open systems will require considerably more systems and data base management support than the AS/400.

It is obvious that downsizing and open systems issues can be symptoms of a much deeper political power struggle.

4. Case Study #4

Case Study #4 is a minicomputer company that downsized its staff by over 60% during the last decade, has introduced an open product line, and is in the process of overhauling its information systems infrastructure. Its downsizing priorities are clearly related to re-engineering systems to support the business. IS management believes that survival in today’s market requires new information systems that can support shorter product cycles with fewer personnel. Corporate management seems to agree with this assessment, and IS is assuming additional responsibility during the fight for survival.

The company still has mainframes installed, and it is estimated that it will be several years before significant progress can be made in distributing data bases from these systems. Applications for downsizing to the company’s UNIX-based systems are selected on the basis of improving productivity of company personnel. Since staff reductions have already been so severe, the object is to reduce overtime and to improve service to customers. Though cost reductions usually can be demonstrated for specific applications that have been downsized, the primary emphasis is on the struggle to remain competitive.

While the company has supported a major advertising effort in the trade press to promote the advantages of open systems, the commitment to a changed information architecture for internal information systems demonstrates a willingness to bet the company that the reported benefits will actually materialize and permit the company to compete effectively in a highly competitive international market. The objective of downsizing is not to reduce IS costs—it is to use information technology to save the company. This is commendable, and during the research for these case studies INPUT found that the company’s new product line is being well received in the marketplace.

5. Case Study #5

Case study #5 is a consumer products company that instituted a crash project to go from mainframes (IBM and Unisys) to a UNIX-based open system (Pyramid). The impetus for this downsizing effort came when the company was acquired by an international conglomerate that had adopted an open system policy. The emphasis was on replacing mainframes as rapidly as possible, and the company feels that two key decisions contributed to the success of the downsizing effort.

- The first decision was not to re-engineer, but to convert as rapidly as possible.
- The second decision was not to hire a major systems integrator, but rather to plan and manage the downsizing project(s) with internal personnel.

It is felt that these two decisions permitted the downsizing project to be completed in a timely manner with minimal transition costs. It was stated that the downsizing effort would still be going on if either of these two decisions had been reversed.

The results achieved were impressive. The base operating budget was reduced from \$3.9 million before the downsizing effort started to a running rate of \$1.2 million in 1992. (It was estimated that \$500,000 was saved in IBM software license fees alone.) However, salary costs have gone up slightly (from \$2.7 million to \$3.0 million), even though head count has gone down. Systems personnel with UNIX and C experience are in demand and can command more money. In addition, to get the downsizing effort under way, more than 900 person-days of training were required for systems and technical personnel—over 10 days per person.

Although the conversion costs were minimized in this case, they were estimated to be approximately \$2 million, and it was emphasized that this estimate was “very rough.” However, with the kind of savings that have been reported in this case, the effort obviously has paid off.

It appears that, when mainframes can be actually rolled out the door, it is easily understandable why downsizing has so much appeal.

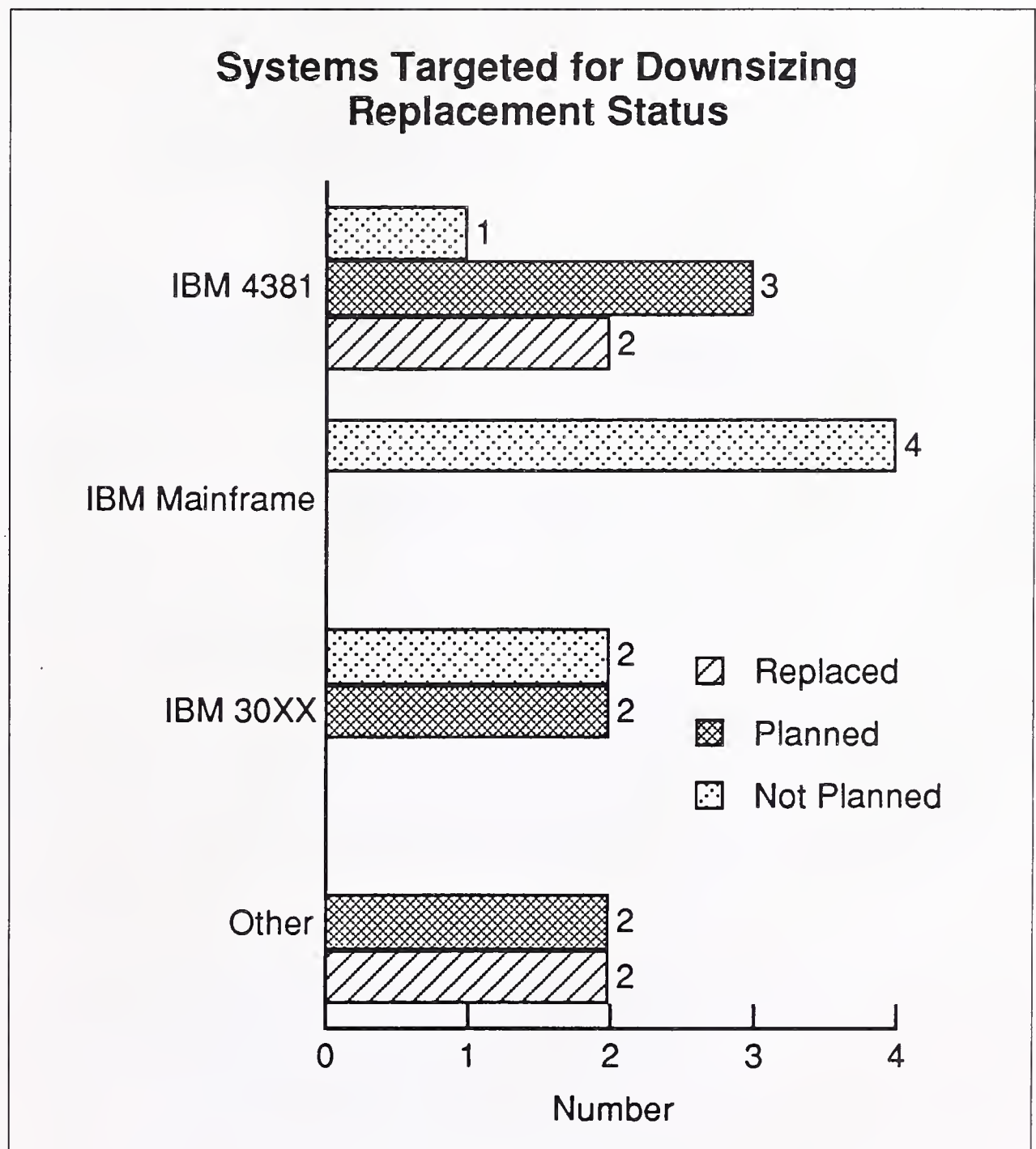
B

Summary of Published Case Studies

The role of the media in influencing corporate management to downsize prompted INPUT to review published case studies. Analysis of case studies appearing in the trade press during the first three months of this year revealed the following:

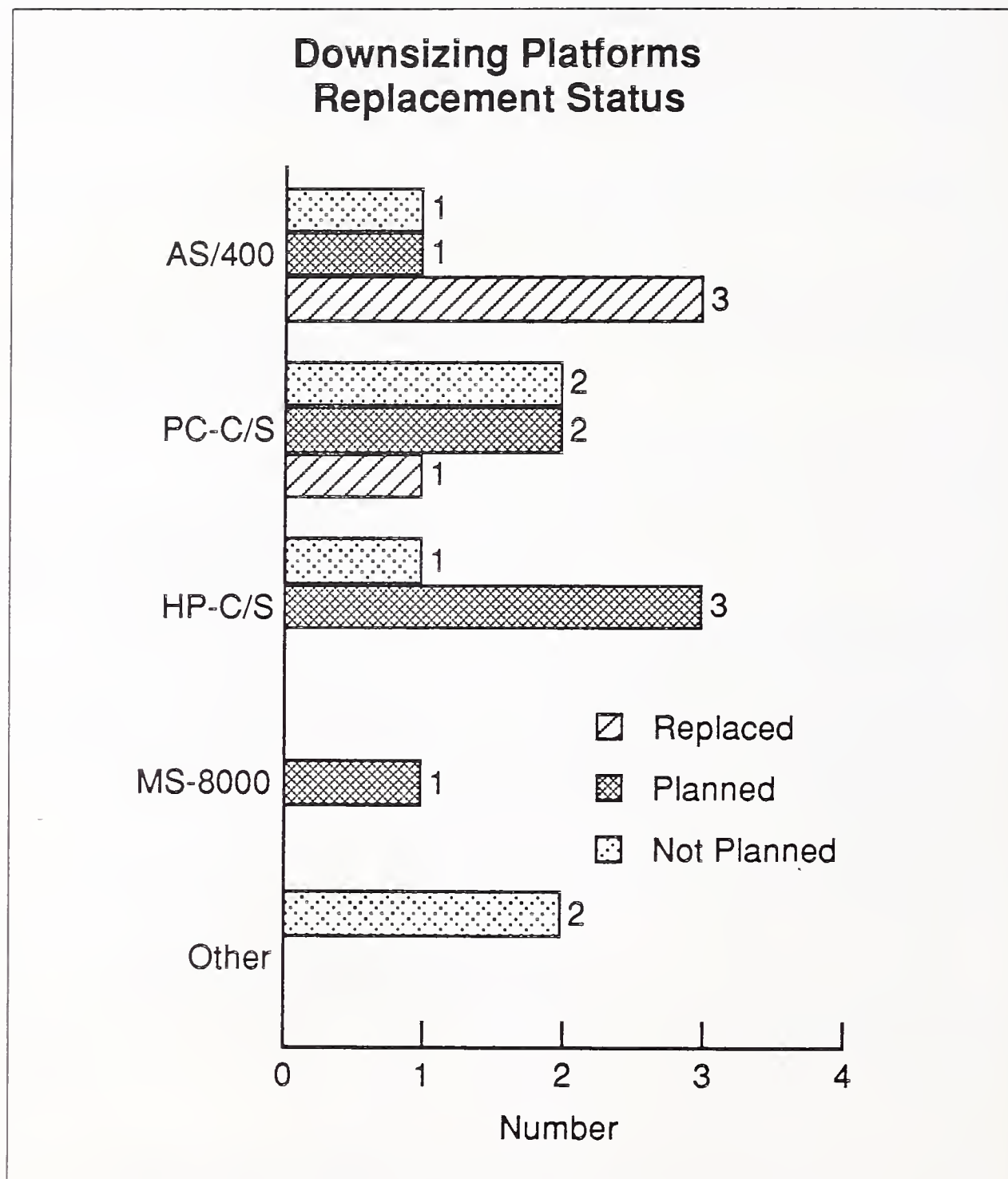
- The primary platform being replaced, or planned for replacement, is the IBM 4381 (see Exhibit II-1).

EXHIBIT II-1



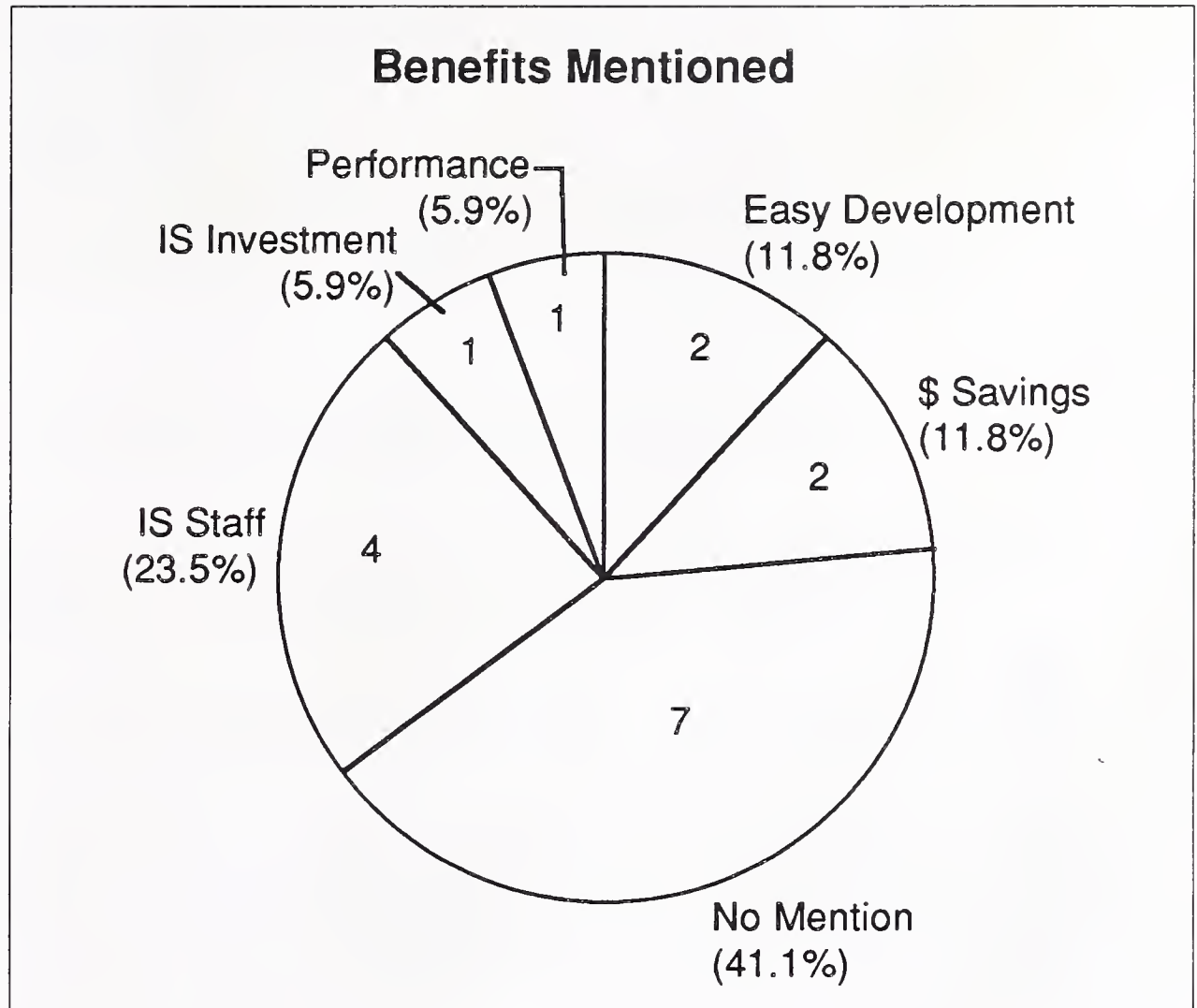
- The AS/400 has been the most successful platform employed in actually replacing mainframes, as shown in Exhibit II-2. This is despite the facts that it is a proprietary system, and that IBM has not seen fit to market it aggressively as a downsizing platform.

EXHIBIT II-2



- Cost savings, either actual or anticipated, are seldom published in these case studies, as is apparent from Exhibit II-3. It seems that corporate executives are not necessarily being misled by the trade press—they are believing what they want to believe.

EXHIBIT II-3



C

General Conclusions

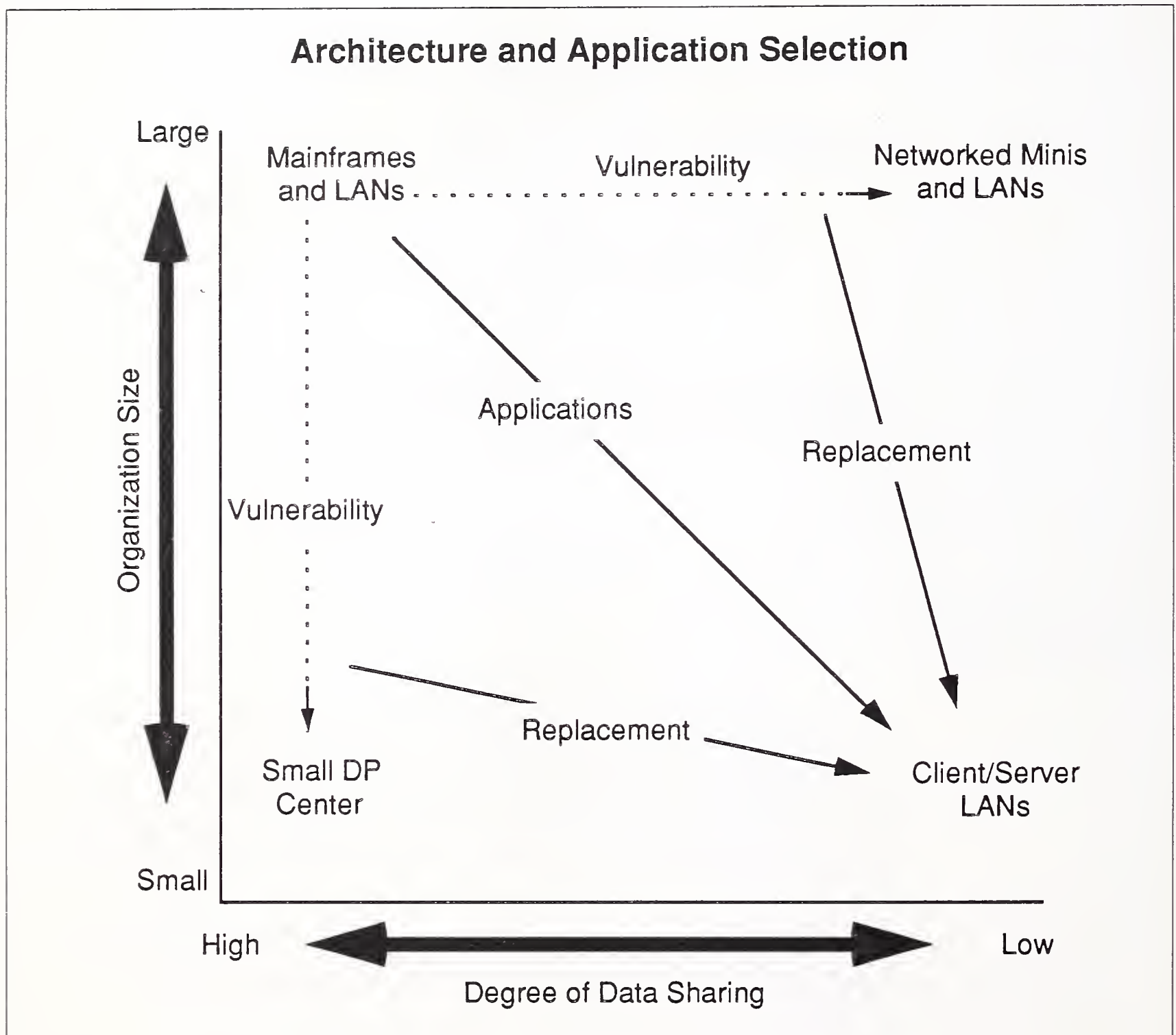
The strategic case studies, the analysis of published case studies, and desk research on the distribution of programs and data in computer networks leads INPUT to conclude that organization size and the degree of data sharing across applications determine the attractiveness of downsizing from a technical point of view. Exhibit II-4 shows data supporting this view.

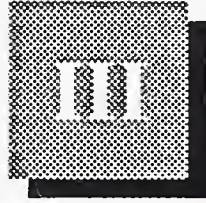
- Large mainframes being used for shared data bases are not attractive for replacement through downsizing, but specific applications may be downsized.
- The low end of the IBM product line is especially susceptible to replacement through downsizing because of the systems software burden and expense.
- Specific cost savings will be more likely to accrue when mainframe systems are replaced rapidly and transition costs are kept to a minimum.

- There can be other benefits of downsizing (including political ones), but these benefits should be carefully analyzed because downsizing can be expensive.

Other conclusions and recommendations are included in Chapter VII of this report.

EXHIBIT II-4





Review of Previous Research

A

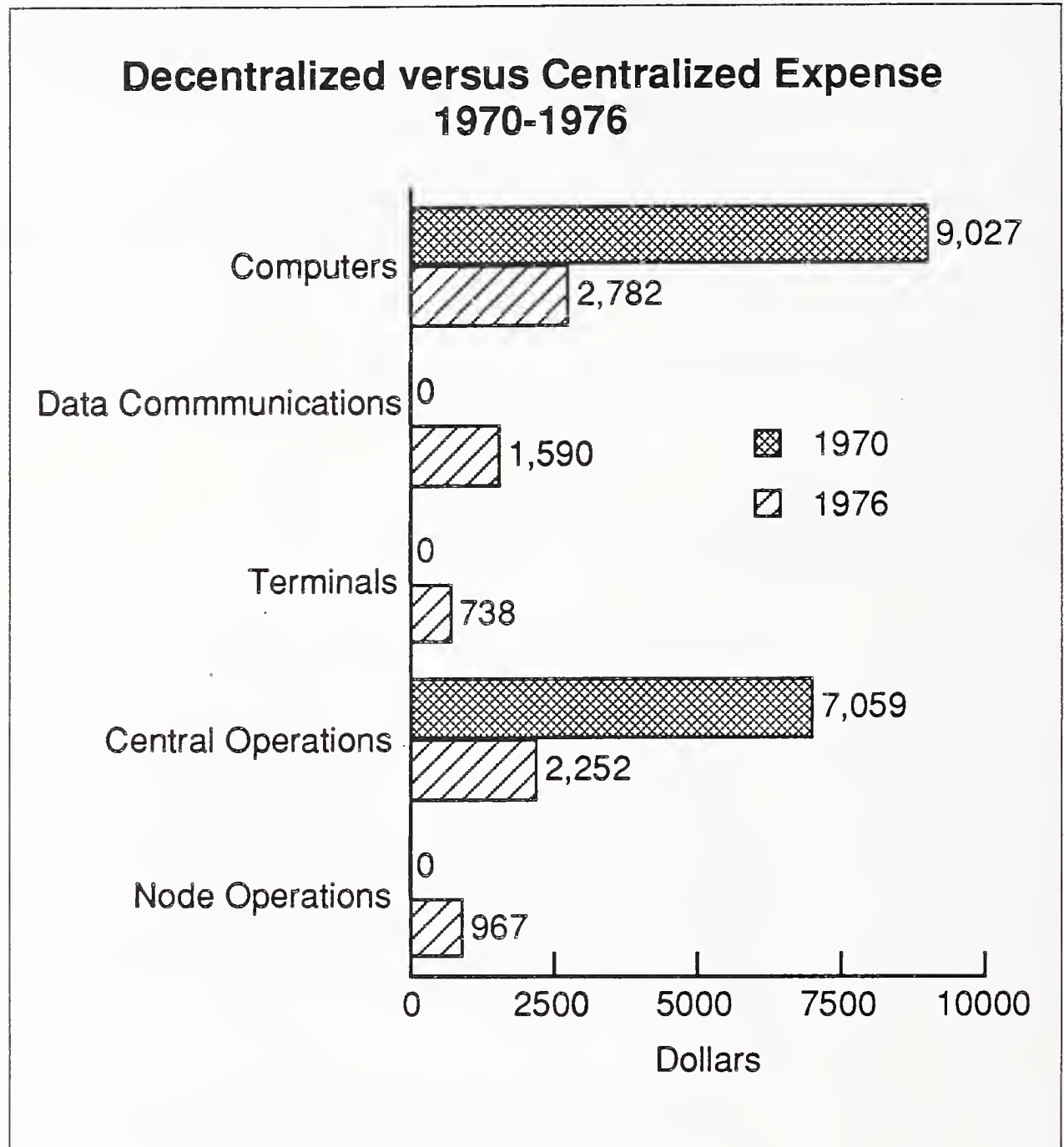
An “Upsizing” Case Study

1. Cost Comparison—Centralization versus Decentralization

One of the first networking studies that INPUT published some years ago was an actual case study of an international conglomerate that consolidated all of its standalone computer operations into a single data center during the early 1970s. [1] This consolidation was based on then-current theories of economy of scale, and was essentially an exercise in “upsizing” within the IBM product line. The documented results of this consolidation showed that “upsizing” posed more of a potential threat to IBM mainframe revenues than does the current trend toward downsizing (see Exhibit III-1).

- Between 1967 and 1970, expenditures for mainframe computers in the company had risen from \$5.5 million per year to just over \$9 million. Then, through the consolidation effort, mainframe computer costs plummeted to \$2.8 million by 1976. This was accomplished by replacing standalone systems with two large mainframes in a central data center and remote job entry terminals located throughout the United States and Europe.
 - Data communications costs were approximately \$1.6 million per year. (These communications costs were allocated and recovered based on computer usage and not actual line costs for the remote nodes, so that users would not be penalized based on geography.)
 - Hardware terminal costs amounted to about \$0.75 million per year.
 - The total cost of the network (mainframe computers, terminals and data communications) was \$5.1 million.
 - It seemed obvious that computer networks were good news for communications-oriented vendors and bad news for mainframe computer vendors.

EXHIBIT III-1



- While the hardware cost savings were substantial, the operational cost savings of the centralized network were even more impressive; this is important when considering downsizing and decentralization.
 - Operational costs (personnel, space, utilities, etc.) in the decentralized environment were approximately \$7.0 million.
 - Once centralized, operational costs for the central site and the 19 remote network nodes were only \$3.2 million.
 - Cost savings alone do not reflect the benefits of centralization. There are also the benefits of improved staff quality in critical areas such as systems programming and data communications, and the improved reliability, availability and serviceability of the central facility (i.e., the installation of an uninterruptible power supply).

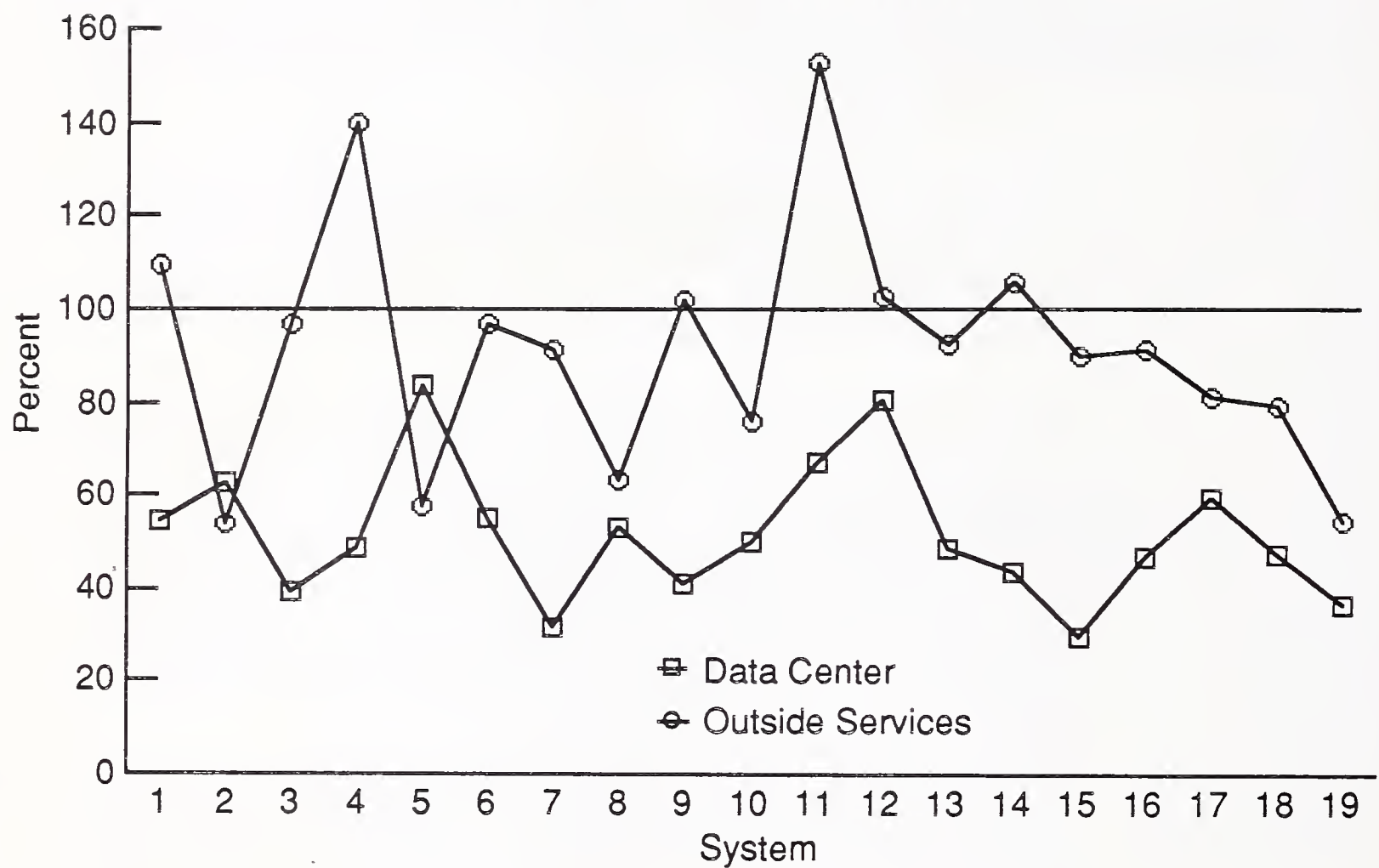
- INPUT concluded that the economics of computer/communications networks (and economy of scale) in the 1970s were such that most large organizations could make more effective use of information technology by consolidating into large corporate data centers, and those organizations that did not require very large mainframes could turn to computer services companies in order to achieve the benefits of economy of scale. This would result in the emergence of long-prophesied computer utilities.
- The impacts of minicomputer- and microprocessor-based workstations (intelligent terminals) on classic economy of scale were anticipated in the report, and INPUT clients were advised to pursue the “orderly distribution of processing” back to end users once the benefits of centralization were achieved.

The fact that INPUT’s advice, based on these logical conclusions, was not generally acted upon during the late 1970s (and throughout the 1980s) requires analysis in order to understand the impetus and impact of downsizing in the 1990s. Exhibit III-2 presents a node-by-node cost comparison of standalone costs, actual data center charges, and the projected charges from outside services companies (based on running actual data through the billing algorithms used by those vendors). Several conclusions pertinent to downsizing can be inferred from this chart and its underlying data.

- The relative cost benefits of centralization into a single data center varied considerably from node to node. Savings ranged from 83% of standalone costs for node #5 to 30% of standalone costs for node #15. This variation in savings was not dependent upon the size of the computer models being replaced (the range of average cost savings by the six model sizes replaced was only from 46% to 55%). This leads to several conclusions:
 - The cost benefits of centralization are relatively independent of the size of decentralized computer installations being replaced.
 - The cost benefits actually realized from centralization are dependent upon how effectively computer technology is being used (rather than the price/performance of the technology itself); and the effective application of technology is not determined by computer system size, but by the quality of personnel and systems software.
 - However, some of the cost benefits of centralization (and upsizing) are independent of how effectively computer technology is employed. These benefits are the lower operational costs (personnel and environmental) that result from merely having fewer computer installations.
 - To the degree that downsizing results in decentralization, it can be assumed that some of the cost benefits of centralization will result in increased operating costs in some downsized environments.

EXHIBIT III-2

Cost Comparison Percent of Standalone Costs



Key	System	Data Center %	Outside Services %
1	S125	54.3	109.4
2	S115	62.4	53.9
3	S115	39.2	96.6
4	S135	48.4	140.0
5	S3	83.5	57.4
6	S145	55.2	96.5
7	S125	31.4	90.9
8	S168	53.2	63.3
9	S145	41.3	101.7
10	S168	50.1	75.7
11	S125	67.0	152.2
12	S158	80.4	102.4
13	S125	48.7	92.3
14	S135	43.5	105.4
15	S158	29.8	89.5
16	S125	47.1	91.2
17	S145	59.5	81.1
18	S115	47.4	79.3
19	S125	36.5	54.2

- The relative costs of outside services also convey valuable information about the economics of both centralization and downsizing (Exhibit III-2), and analysis reveals why computer utilities have been so slow to develop.
 - As a general observation it can be stated that the actual data center charges were generally substantially below those that would have been charged for comparable workload provided by outside vendors.
 - Even casual observation reveals that outside computer services vendors were unable to provide any cost savings for a number of the standalone installations, and for two of the nodes (4 and 11), the costs would have risen substantially.
 - One of reasons that computer services companies were not competitive with internal computer installations (much less the data center) was that many of them concentrated on specific market segments and were not able to keep their systems busy or provide needed services. The timesharing companies could not compete effectively in the batch processing market, and the batch processing vendors did not install systems that provided fast turnaround (or interactive processing).

The case study company, by being on the leading edge in wide-area networking, was able to keep its large mainframes busy by channeling all of the computer workload scattered across nine time zones through a central computer facility. This permitted a couple of mainframe computers, with less processing power and less main memory than current desktop computers, to handle all of the data processing for a \$2 billion corporation, poll several thousand point-of-sale terminals, and still have capacity to provide outside computer services.

For large mainframe installations that were not “communications oriented”—and in the early 1970s most of them were not—the primary problem perceived for large mainframes was how to “keep the CPU busy.” The “solutions” to this problem have created the current information technology architecture that is the target for downsizing.

2. Keeping the Mainframe Busy

The “upsizing” case study company was able to keep the CPU busy by batching all transactions and data (some on distributed minicomputers), transmitting them over communications lines specifically tailored to volume (lines from 1200 baud to 50KB were employed), processing these transactions against specific files, and generating all necessary operating and management reports. It operated within the limitations of its memory by employing multiprogramming with a variable number of tasks (OS/MVT).

The network worked well and provided cost-effective information systems whether servicing retail stores, manufacturing plants, sales organizations, research facilities, or a variety of advanced electronics and aerospace facilities. It made effective use of its limited (by today's standards) mainframe MIPS and memory. It was essentially a batch processing engine with communications capability and was not intended to handle interactive processing; that was left to distributed minicomputers and intelligent workstations.

Since this architecture permitted large mainframes to gobble up their smaller siblings at an alarming rate, and offloaded interactive work to those pesky minicomputers, it is not surprising that it did not have much appeal for those with vested interest in the broader spectrum of mainframe technology. The trick for them was to keep the large mainframes busy on something other than fratricide, and IBM accomplished this in admirable fashion. The winning combination was virtual storage operating systems (culminating in MVS/ESA), SNA (culminating in the de facto networking standard for commercial data processing), and data base management systems (culminating in both IMS and DB2).

- Virtual storage operating systems were so successful in consuming mainframe MIPS that the early versions spent all their time keeping track of where everything was, and the mainframe had no power left over for running user "problem programs." This was called "trashing," and even the most tolerant customer had to admit that the systems overhead was getting a little high. The trashing problem was "fixed," but the overhead of virtual storage operating systems lives on in terms of both MIPS consumed and real memory required to house the operating system. Virtual storage has a big role to play on both clients and servers in the downsized environment, and the quality of implementation—in hardware and/or software—will be an important architectural determinant of performance in the downsized environment.
- SNA was designed to keep practically all processing on the mainframe host, and in this it has been remarkably successful. Transient phenomena such as having the mainframe refresh "clocks" on terminal screens, and routing messages thousands of miles through a mainframe when the recipient is practically next door, have occasionally surfaced to warn users of this excessive mainframe orientation. However, commercial customers have been surprisingly tolerant as they have continued to upgrade mainframes to perform functions that could be more economically handled at other levels of the processor hierarchy. There are many such "improper" functions (and applications) trapped, and hidden, on mainframes by SNA; and these have been and continue to be attractive targets for downsizing.

- One of the reasons users found it difficult to keep large mainframe CPUs busy is that commercial applications have traditionally been I/O-bound (unlike scientific and engineering applications that have been compute-bound). Data base management systems have gone a long way toward “correcting” the commercial imbalance. Transactions that required the execution of a few hundred (or less) instructions in a serial batch environment suddenly started requiring hundreds of thousands of instructions when a DBMS (IMS) was installed, and the performance problems associated with the relational model kept DB2 from becoming a product for approximately 10 years. The relational model is the data model of choice in the downsized environment.

Mainframe computers exist, and are necessary, to run this complex set of systems software. The biggest investment that mainframe users have made is not in their (COBOL) applications; it is in following IBM’s operating systems, network architecture, and data base management strategies. It is the whole top-heavy information architecture that resulted from these strategies that is now under attack by the advocates of downsizing. The targets of this attack vary considerably in terms of their vulnerability.

3. Target Selection

It is assumed that scientific and engineering work, whether on a mainframe or a minicomputer, will naturally gravitate toward the most cost-effective platform. The cost savings are easily measured and relatively easy to obtain. The same applies for text processing and publishing applications in the commercial world. It is not necessary to invent new terminology or have conferences to encourage computer users (or even IS) to adopt innovations with obvious benefits.

Current downsizing efforts are directed toward mainstream commercial applications involving large data bases and transaction processing, and here the benefits are not so obvious. However, there are attractive targets of opportunity for downsizing mainframe commercial applications.

Smaller mainframe systems (such as the 4381) that serve as bridge systems to the MVS/ESA, SNA, IMS-DB2 worlds are especially vulnerable to attack. They can hardly carry the overhead burden of the systems software and have little capacity left over for user applications. It is not by chance that many of the publicized cases of mainframes being replaced by downsizing are 4381s.

In addition, some application systems are attractive regardless of the size of mainframe involved. They simply don’t require either the functionality or robustness of mainframe systems software because they are relatively independent in their data dependencies. The overhead burden and complexity of mainframe systems software in these cases is not justified, and these applications provide attractive targets for downsizing to more cost-effective platforms.

Cost/benefit problems start to arise when applications have data dependencies across organizational lines—in other words, when the applications environment requires the large data bases and high transaction rates that mainframe systems software was designed to accommodate. However, even then it is probable that many of these applications can be re-engineered to take advantage of advances in information technology, and specific mainframe functions can be cost effectively downsized.

The central issue that will arise as downsizing proceeds will be the relative advantages (and disadvantages) of centralization versus decentralization. Will the theoretical cost savings based on improvement in hardware price/performance disappear because of increased operating costs in the decentralized (or distributed) environment? Because INPUT was aware of the benefits of “upsizing” (centralization), it decided that the current trend toward downsizing had to be carefully analyzed to determine the cost/benefit trade-offs between the two environments.

Let us review, very briefly, the pertinent highlights of INPUT’s downsizing research to this point.

B

Putting Downsizing in Perspective

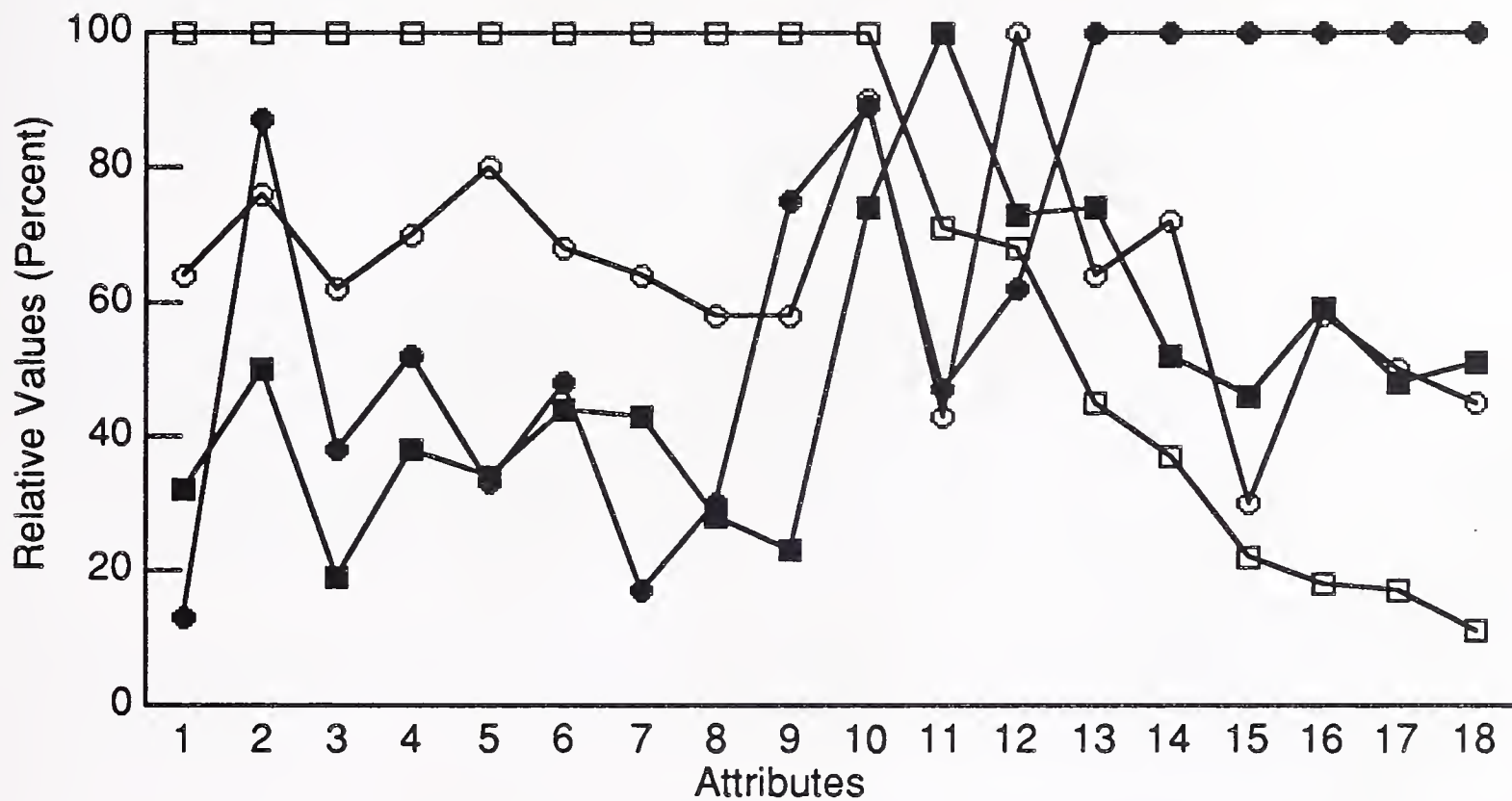
1. Platform Report Card

INPUT asked IS management to rank the major hardware platforms on various attributes; the results are shown in Exhibit III-3. Although the chart may seem a little complex, the “grades” on the “report card” are not. IS management feels strongly that:

- Mainframes excel in all of the attributes that are usually deemed important for traditional commercial applications, even if this is accomplished at the expense of “complexity.”
- Minicomputers are best suited for distributed data servers.
- RISC-based workstations are best for scientific (and engineering) applications.
- PCs stand out as being easy to use and cost effective.

EXHIBIT III-3

Hardware Platform Report Card IS Management



□ Mainframe ■ RISC
 ○ Mini ● PC

Key	Attribute	Mainframe	Mini	RISC	PC
1	Security	100	64	32	13
2	Connectivity	100	76	50	87
3	Commercial Applications	100	62	19	38
4	Reliability (H/S)	100	70	38	52
5	Data Management	100	80	34	33
6	Network Management	100	68	44	48
7	Complex	100	64	43	17
8	Vendor Support	100	58	28	30
9	Applications SW	100	58	23	75
10	Architecture (H/S)	100	90	74	89
11	Scientific Applications	71	43	100	47
12	Distributed Data Server	68	100	73	62
13	Cost Effective	45	64	74	100
14	Easy to Program	37	72	52	100
15	Open Architecture	22	30	46	100
16	Good Bargain	18	58	59	100
17	Easy to Use	17	50	48	100
18	Easy to Operate	11	45	51	100

While vendors generally agreed with IS management's evaluation on 14 of the 18 attributes, they dissented on the following:

- Vendors ranked PCs best for connectivity and applications software, but mainframes were a close second by having "grades" of 91 and 97, respectively.
- Vendors ranked RISC-based workstations better than PCs for open architecture, and better than minicomputers as distributed data servers. In addition, RISC-based workstations shared the top ranking for cost effectiveness with PCs in the vendor rankings.

Despite the fact that both IS management and vendors gave high grades to mainframes on many of the essential attributes of mainstream commercial applications, both sets of respondents agreed that mainframes would cease to be the predominant platforms for many commercial applications during the 1990s. Generally speaking, downsizing will favor PCs and workstations at the expense of both mainframes and minicomputers, with IS management more favorably disposed toward PCs and vendors more favorably disposed toward RISC workstations.

However, the strong support for downsizing remains difficult to rationalize in light of the strong support exhibited for mainframe commercial systems in Exhibit III-3.

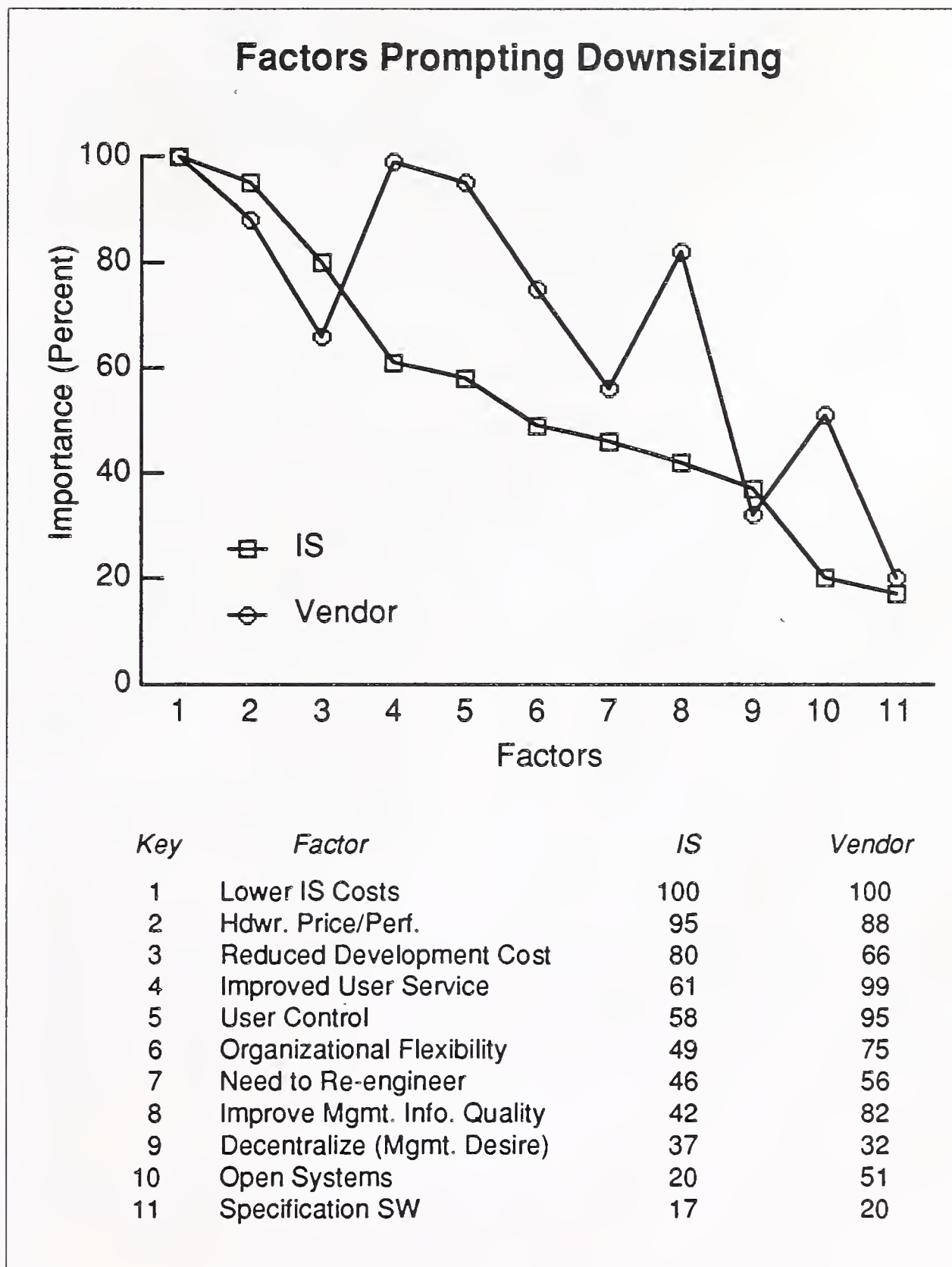
2. Factors Prompting Downsizing

According to IS management, the top factors prompting downsizing were all directly related to reducing the expenses associated with information technology, as shown in Exhibit III-4. While vendors agreed that the most important factor prompting downsizing was reduced IS costs, they felt that improved user service and control were just as important (ranking those factors at 99% and 95%, respectively).

Though IS management felt that cost savings were the primary factors prompting downsizing, it was much more difficult to get agreement that cost savings would actually be realized.

- Only 65% of IS management felt that hardware costs would actually be reduced (compared to 85% for vendors).
- Only 62% felt that downsizing would reduce the role and expense of IS (compared to 78% for vendors).
- Only 46% felt that software expense would be reduced, and vendors were in agreement with this assessment since only 44% of them felt that software expense would be reduced.

EXHIBIT III-4



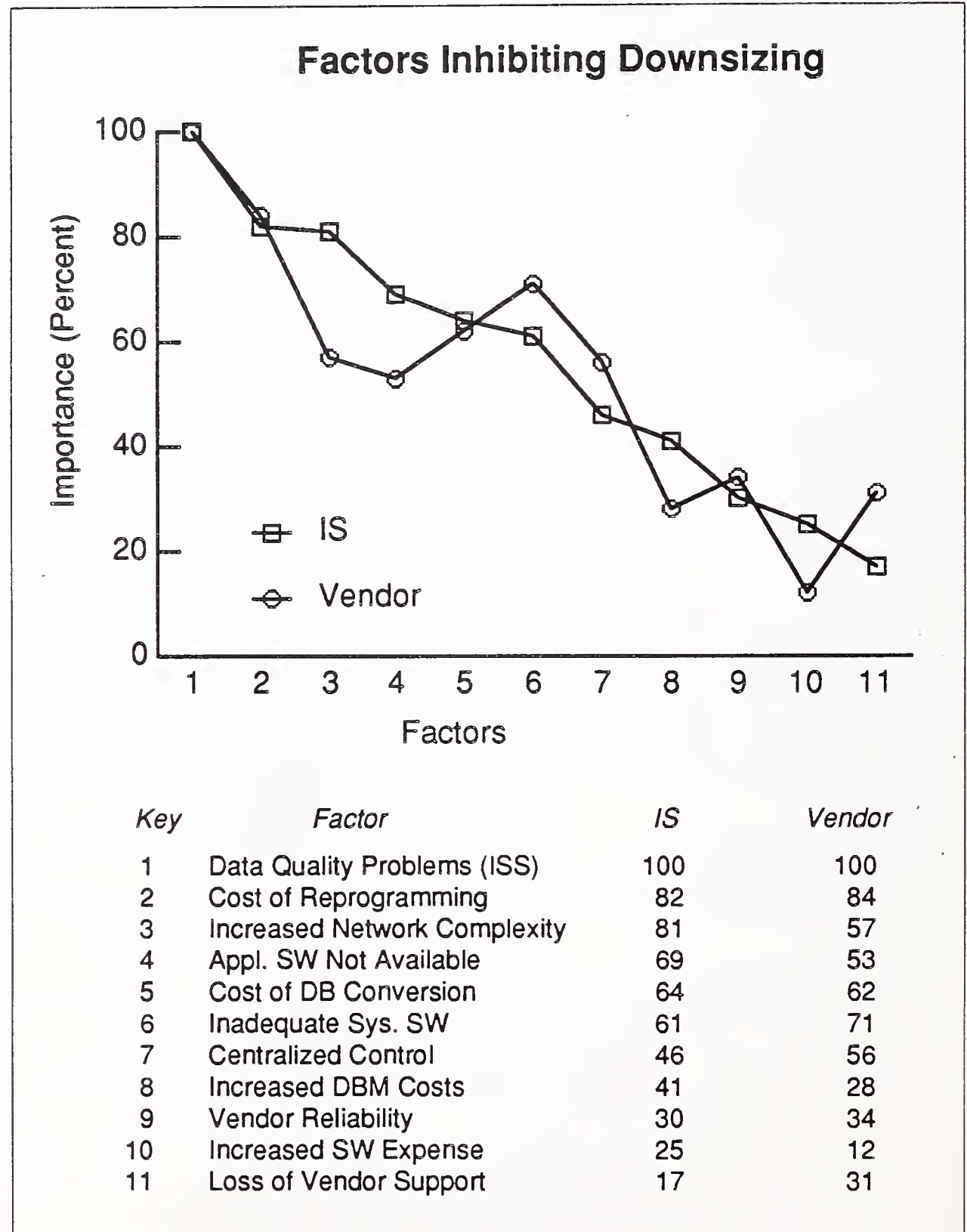
- Only 33% felt that downsizing would result in better management control of information resources (compared with 67% for vendors).

It can be concluded that some of the impetus for downsizing is coming from corporate executives and end users, and that IS management is not especially confident that the goals and objectives of downsizing will be realized.

3. Factors Inhibiting Downsizing

Both IS management and vendors agree that the main factor inhibiting downsizing is associated with data base management (see Exhibit III-5). This factor was defined as being a problem of data quality in terms of data base integrity, synchronization, and security; it is precisely here that the strengths (as defined by IS management and vendors) of the mainframe and centralization come into play.

EXHIBIT III-5



What IS management seemed to be saying was this:

- Operating executives and end users think they can cut information systems costs by taking advantage of the vastly improved price/performance of new technologies such as RISC workstations and networked PCs.
- We aren't too sure that any actual cost savings will result from downsizing, but the groundswell is so great that we have to "go with the flow."
- There is a very real possibility that downsizing may result in data problems if we aren't careful.

INPUT doesn't know how individual IS managers are handling this situation, but it is certain that a high percentage (over 80%) had specific downsizing plans, and many projects were already under way. This led INPUT to conclude that both the economics of downsizing and the technological risks associated with a new information architecture required more detailed study. INPUT decided to focus on the architectural issues first.

C

Systems Architectures for Downsizing

INPUT determined that an analysis of systems architectures required looking "behind the screen, at the screen, and beyond the screen." In the process of doing this INPUT isolated some fundamental competing concepts among the mass of "terminological inexactitude" that was identified at the beginning of the research when even such terms as downsizing, client/server, and application were at issue.

Exhibit III-6 reviews what is seen behind the screen, at the screen, and beyond the screen.

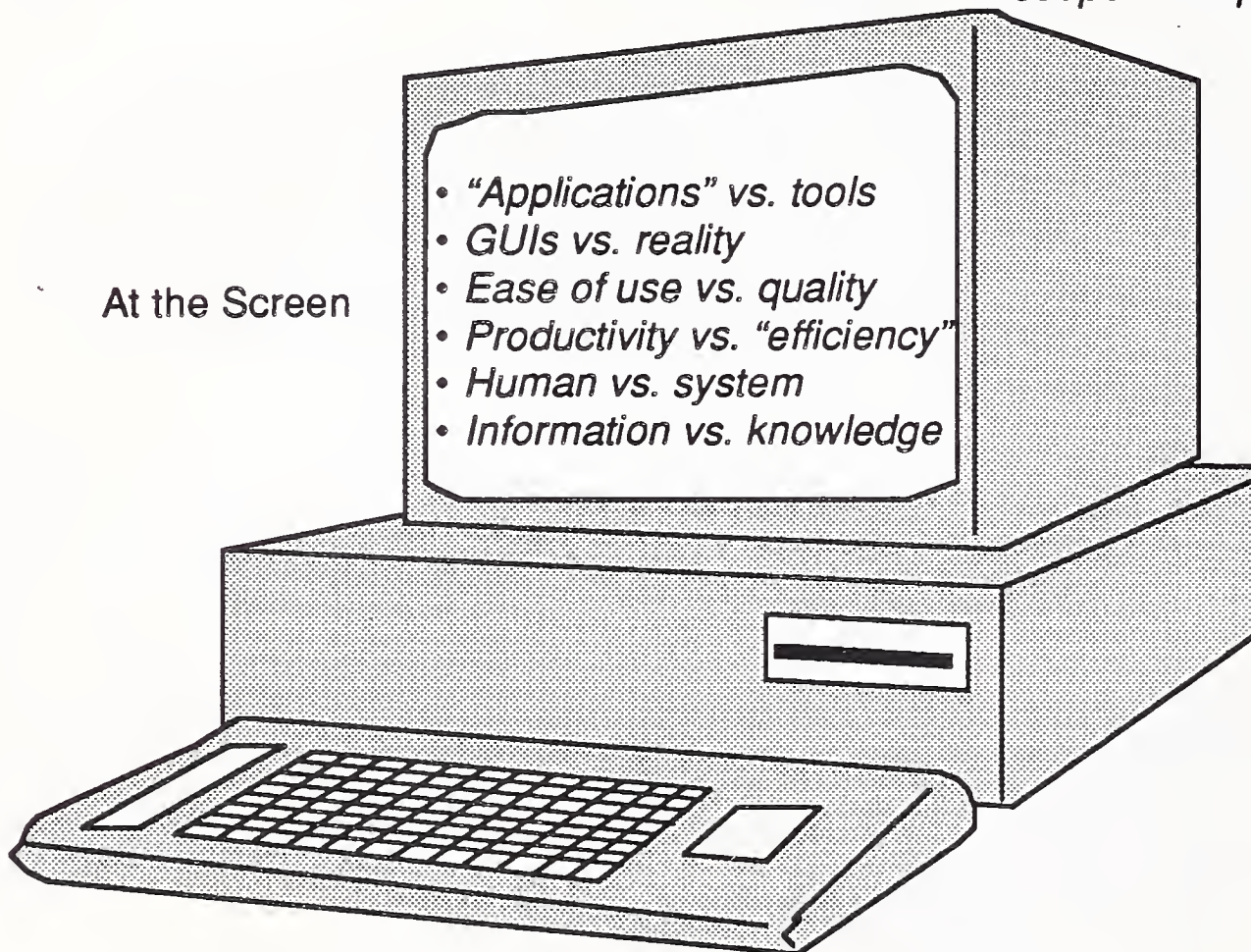
EXHIBIT III-6

Downsizing Issues

Behind the Screen

- *RISC vs. CISC*
- *UNIX vs. proprietary*
- *DBMS vs. DDBM*
- *Host vs. peer-to-peer*
- *Client/server vs. cooperative processing*

At the Screen



- *"Applications" vs. tools*
- *GUIs vs. reality*
- *Ease of use vs. quality*
- *Productivity vs. "efficiency"*
- *Human vs. system*
- *Information vs. knowledge*

Beyond the Screen

- *Centralized vs. decentralized*
- *Top-down vs. bottom-up*
- *IS vs. management*
- *Innovation vs. culture*
- *Control vs. empowerment*

1. Behind the Screen

- Hardware architecture has resurfaced as a controversial issue that pits the advocates of reduced instruction set computers (RISC) versus complex instruction set computers (CISC). INPUT made the following observations:

- This is not a new issue. What should be built into hardware and what should be left for software has been a controversial subject among computer architects for decades.
- MIPS are a poor measure of the performance (much less throughput) of RISC processors because so much dependency is placed upon the quality of systems software (specifically compilers).
- In addition, the RISC architecture is best suited for binary arithmetic rather than data manipulation—a fact that is important when downsizing commercial applications.
- The UNIX versus proprietary operating system argument has also been going on for more than a decade, but it has now taken on the attributes of a holy war that finds the sects of the open systems fanatics battling among themselves.
 - UNIX has yet to prove itself in the mainstream commercial market, and it is not currently competitive with mainstream operating systems at the mainframe and minicomputer levels.
 - It has had only minimal impact in the personal computer market, and operating systems developments (specifically OS/2) threaten to leapfrog its capability there.
 - It is unlikely that a “standard” UNIX will ever emerge from the various competing efforts, and is doubtful UNIX will ever catch up with major proprietary operating systems for commercial applications.
- While relational (or relational-like) data base management systems are the clear winners in the downsizing (or distributed) environment, the many problems associated with distributed data base management have yet to be solved. This is the reason that IS management expresses concerns about data base integrity, synchronization and security. The following conclusions can be reached about this key issue:
 - Existing corporate data bases (many of them based on the hierarchical model as implemented in IMS) will not be readily replaced for many years.
 - IBM’s Systems Application Architecture (SAA) is the most comprehensive plan for distributed data base management (DDBM) that is currently available, and downsizing is heavily dependent upon DDBM.
 - Most downsizing efforts will require integration with SAA data bases at some level in the network hierarchy.

- SNA is the backbone network of choice in the commercial world. Despite all of the talk about open systems, surprisingly little progress has been made. SNA has been excruciatingly slow in the distribution of function from mainframe computers despite all of the talk about peer-to-peer architectures. During the course of INPUT's downsizing research, IBM has (again) endorsed its advanced peer-to-peer networking (APPN), but it currently exists only on OS/400 and OS/2 platforms. The mighty host condescends to downsizing with extreme reluctance.
- The IBM model for downsizing is cooperative processing, which has been roughly defined for over five years and is the key architecture for SAA. Client/server is a relatively recent term that is more all-encompassing than cooperative processing (though there are some who would dispute this). Cooperative processing depends upon DDBM; client/server is used for everything from shared file, through file transfer, to full distributed data base management (or cooperative processing). However, it doesn't make any difference whether you are downsizing from mainframes or integrating a bunch of personal computers on a LAN, you will still wind up with a "client/server architecture."

2. At the Screen

The screen is where the human meets the machine, and everything that goes on behind the screen should be transparent, and of no concern, to the user. Computer vendors have been saying this for years, but try to tell that to the poor soul who is struggling with memory management on a PC, or who is confronted with unexplained system crashes or network failure. A lot of people may have become "computer literate" during the 1980s, but this type of literacy has come at high cost.

Much of this we blame on software vendors who seem to have little awareness of how computers are actually employed in business.

- The clearest evidence of this is the redefinition of the term "application," which has been misapplied to include applications enabling tools at the personal computer level. Spreadsheets and DBMSs are not "applications"—they make no direct contribution to accomplishing the role of the individual or organization employing them. This will become patently clear as users attempt to downsize real applications using shrink-wrapped tools.
- Graphic user interfaces (GUIs) are currently all the rage, but they do not hide what is behind the screen. Just ask the users of Windows 3.0 whether or not they had to be concerned about what was going on when their systems failed. Now, we have Windows 3.1 and it is being labeled an "operating system." It just ain't so folks—DOS remains the operating system regardless of how many shells and pretty wrapping paper we put around it. Even such restrictions as the length of file names can be extremely annoying to those accustomed to the Apple II or Macintosh.

- The underlying architecture at the screen also becomes important in terms of trade-offs between ease of access (to either other systems or data) and data quality. There are good reasons that published security violations usually involve UNIX-based networks, and viruses plague personal computers.
- It is becoming increasingly apparent that putting white-collar workers at computer screens has not made them more productive, and yet employees are theoretically more efficient in what they are doing. This problem is not going to go away by providing more hardware or software tools—the office process beyond the screen must be addressed.
- Depending upon the architectural quality of the specific application, it is possible to put humans in an adversarial relationship with the system. When the system has the capability of measuring human “productivity” down to the keystroke (or mouse click), the office worker can feel as chained to the machine as did any piece-work employee before the days of blue-collar unions. And this adversarial relationship is not restricted to clerical workers; the term “intellectual rate busting” has already begun to creep into trade literature. [3]
- There is a general misconception that information by its very nature is good, and that anything displayed on the screen has value. This is not true. It is obvious that the quality of information will depend upon the data base, but it should also be recognized that the quality of information depends upon the knowledge of the person who developed the information. It is easy for anyone to develop pretty reports, but this does not mean that the content can’t be nonsense. The architecture of the information system—whether decision support or voice mail—should include the provision for input of, and access to, human knowledge.

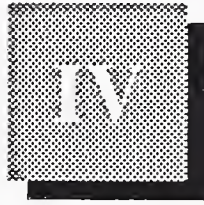
3. Beyond the Screen

Beyond the screen of information technology, the impacts of the long-awaited “information age” are taking place. In parallel with the downsizing of mainframe computer systems, there is currently a management trend toward organizational downsizing. This trend manifests itself in reduced head count—especially in middle management. As the organizational structure changes, so does the “information architecture” of the enterprise.

Though it is difficult to determine the exact relationship between technological downsizing and management downsizing, there is no question that there is a heavily interdependent relationship between the two. The most important issues associated with downsizing depend upon the nature of this relationship. They are as follows:

- The previously mentioned issue of centralization versus decentralization goes well beyond the economics of the situation. For example, it has recently been reported that some CIOs are downsizing themselves out of their jobs. [4] As the IS function is decentralized to operating levels, the Indians get dispersed and there is no need for a chief.
- In the decentralized environment, the classic top-down design concepts of structured programming are abandoned for a bottom-up approach that is reminiscent of the early days of computing. Though this dramatic architectural shift has been prompted by the failure of the “big bang” theory of systems development (where all of the data requirements for all time had to be defined first), it is wise to remember that the horrible integration problems associated with individual applications were what prompted the development of corporate data bases. The pendulum always seems to swing too far.
- The IS department has been placed in an adversarial position with operating management because it has frequently been identified as an extension of the corporate controller and planning functions. Many line managers feel they are being asked to supply data to feed information systems and receive very little help with their information requirements. When IS spends too much time concentrating on the screen and what is behind it, the needs of the business have not been well served.
- Regardless of the rationale for downsizing, there is no question that major innovations (both technological and managerial) will occur rapidly in the 1990s. It is doubtful that organizational culture will be able to keep up with these changes. The IS department is very much a part of the establishment, and the establishment does not change gracefully—that is what cultural lag is all about. (It was recently reported that Bruce (Tog) Tognazzini—Apple’s “Evangelist of the Interface”—has left for the less structured environment of Sun Microsystems. Cultural lag works both ways.)
- The major downsizing issue is that of central control versus individual empowerment. It will require drastic changes in the mindset of both management and employees if desired results are to be achieved. Although information technology is an important ingredient of downsizing, the human and organizational considerations predominate. Achieving a balance between central control and empowerment will be the key to success in the 1990s.

Because of the complexity of the issues outlined above, INPUT decided that strategic case studies (rather than tactical case studies, which are related to specific projects and/or applications) were necessary.



Strategic Case Studies

The subjects of these strategic case studies have been drawn from among leaders in the application of information technology. This means that they have made a continuing effort to rightsize and take advantage of emerging technologies. They upsized when economy of scale dictated; they distributed processing where appropriate; they downsized before the term became popular; and now they confront the 1990s with knowledge of both the potential and the limitations of technological “solutions” that are currently in vogue.

Precisely because most of them have made effective use of information technology as it has emerged, the value of their experience and knowledge frequently lies in defining the limitations (rather than the potential) of new information technology. IS management in these case study organizations frequently talks about information architectures and data quality rather than MIPS and GUIs. This is not always popular with corporate executives and end users who have gained some measure of computer literacy through experience with personal computers and reading the trade press.

T.S. Eliot once raised the following questions:

Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?
(The Rock, 1934)

These are appropriate questions to ask ourselves as we proceed in the “Information Age.” In fact, knowing what we know today it is possible to ask some additional questions:

Where is the information we have lost in data?

Where are the data we have lost in computers?

These strategic case studies have been selected with the intent of identifying data in computers, information in data, knowledge in information, and wisdom in knowledge. In other words, we will isolate the major management and technical issues that are driving the trend toward downsizing, and the approaches that are being taken to reconcile these issues.

- Case Study #1 is a university that is in the process of defining a long-range information architecture (which it assumes will be client/server), and it developed a comprehensive cost model for use in determining where costs will decrease and increase.
- Case Study #2 is a railroad that has been on the leading edge in adapting computer and communications technologies to the operational aspects of its business. It has gone through various phases of centralization and decentralization in employing information technology to build the data bases necessary to serve its customers. It nevertheless finds itself ensnared in an expensive systems software trap on its mainframe computers.
- Case Study #3 involves an international energy company that has essentially managed to avoid the large mainframe trap, only to find itself currently embroiled in an open versus proprietary systems controversy when attempting to downsize an inherited IBM mainframe. An extensive AS/400 network is being threatened by UNIX servers.
- Case Study #4 is a minicomputer vendor that has experienced major organizational downsizing and is now attempting to recover by embracing open systems in its product line and in its internal systems operation. Improved internal systems are viewed as being essential in order to remain competitive, but mainframes will remain installed for some time.
- Case Study #5 is a medium-sized consumer products company owned by a major international conglomerate that is committed to open systems. The case study company eliminated mainframes by pursuing an aggressive conversion program supported by a substantial upgrading of IS staff skills.

In the chapter following the strategic case studies, INPUT will analyze some of the downsizing case studies that have appeared in the trade press.

A

Case Study #1—Modeling Costs in the Downsizing Environment

1. Background

This case study organization is a major university that has contributed substantially to the development of Silicon Valley and the hardware/software technologies that support downsizing. Its IS department has been on the leading edge in developing systems software, networking, and office automation. The campus has served as a test site for many advanced hardware/software technologies. The overall computing environment is fragmented among administrative, academic, and research departments, and the professional schools. A vast assortment of mainframes, minicomputers, RISC workstations and personal computers are installed and connected to the campus network.

The primary focus of this case study is on the potential impact of downsizing on the mainframe data center (IBM ES/9000) that supports centralized financial and administrative applications, as well as such centralized services as electronic mail, appointment scheduling, and on-line forms; and on the communications services department that is responsible for the campus network. These centralized applications and services have been implemented with heavy reliance on home-grown systems and communications software, and institutional data bases have been built (and are being managed) using an in-house-developed DBMS.

Since these centralized applications and services have been in place for a number of years, a management decision was made (a few years ago) to “disperse” IS personnel to user departments. However, the data center retains a cadre of operations, systems programming, and information systems professionals. Data center costs are accounted for meticulously and recovered based on use of the data center.

While some of the accounting practices of the data center are dictated by government research contracts, they are quite common in any large shared computing facility. It is also quite common that users are never satisfied with data center rates, and this is especially true in an environment where there are so many computer experts (both real and imagined) scattered among the user base.

It is little wonder that downsizing is an extremely popular subject. Costs are under close scrutiny; users are extremely knowledgeable about downsizing technologies; and universities are information oriented. It is also little wonder that IS management is assuming that the architectural trend of the 1990s will be toward client/server computing. The past technological and political history of the university indicates clearly who will prevail in any controversy between the central IS function and user departments—

empowerment is a way of life in an academic environment. However, it is surprising that IS management is not only focusing on a long-range information architecture, but also on the cost and funding of downsizing. INPUT found a little wisdom among all that university knowledge that sometimes gets lost in the overload of information.

a. Factors Prompting Downsizing

The specific factors prompting downsizing at the university are:

- Lower IS personnel costs
- Better hardware price/performance
- The ability to use off-the-shelf software packages (both systems and applications)
- Improved decision support systems for both the administrative and the academic sides of the university

b. Factors Inhibiting Downsizing

The factors viewed as inhibiting downsizing are:

- The data and applications that are installed on the mainframe are difficult to replace because the university standardized on its own internally developed DBMS in 1982. (While this problem may appear unique to the university, it is comparable to having any hierarchical or network DBMS as the applications foundation—the relational model reigns supreme in the downsizing environment.)
- There is an existing and continuing investment in mainframe technology. It is estimated that at least two more major mainframe upgrades will be required before growth can be stabilized, much less downsized. (Once caught on the mainframe growth escalator it must be ridden to the next floor before one can start to descend—trying to run frantically down the up escalator is extremely dangerous!)
- The internal application development tools and infrastructure are “different” than those available on the commercial market—sometimes they are better and sometimes not as good, but they are always different. In the case of the campus network, there are currently no commercially available products that could effectively integrate the hodge-podge of equipment that is currently installed.
- Financial applications will be extremely difficult (if not impossible) to manage during any transition period—even if it could be demonstrated that downsizing might be cost effective. As long as these applications remain on mainframes, the economics of downsizing ancillary applications become highly questionable.

c. Applications

New applications, such as image processing, will be implemented using new technology. For example, the university is using RS/6000s for its image processing prototype systems. (The cost of running ImagePlus on an IBM mainframe that does not have IMS, DB2, and CICS installed was more than enough to discourage any thoughts of “experimenting” with image processing on the mainframe.) It is probable that these new applications will eventually “attract” their data processing components from mainframes. In other words, it will be easier and more cost effective to integrate the data base down to the image base, rather than to integrate the image base upward to the data base.

As far as actual planned downsizing is concerned, it seems obvious that ad hoc reporting will be downsized, and the “dispersal” of the IS function to user departments facilitates this approach. Pair-wise connectivity between mainframe data bases and departmental (or personal) data bases is a natural consequence of making systems personnel available to user departments. However, it has already been determined that IS personnel assigned to the user departments have practically no time for any type of development work—they are too busy doing routine maintenance, ad hoc reporting and end-user consulting. End users are satisfied in this environment, but management tends to get frustrated because new development suffers. Therefore, a client/server infrastructure will be slow to develop in the decentralized environment, and it will tend to be inconsistent (and expensive) at best.

The central IS department’s leadership in developing an information architecture for the next century seems to be essential if applications selection and infrastructure changes are to proceed on a planned basis. Actual application selection has not yet taken place, but it is anticipated that major applications that are downsized to more cost-effective platforms will remain the responsibility of the data center for purposes of operational and data base management.

d. Platform and Architecture Selection

IS management is maintaining a position of leadership in platform and architecture selection for the “architected” (or centralized) side of downsizing. It is anticipated that RISC file servers coupled with the mainframe data bases will be housed in the central data center, and the IS department has already standardized on Macintoshes. However, a variety of equipment will continue to be installed over the greater campus network, and the central IS function recognizes that coexistence (and various levels of integration) will remain a way of life for the foreseeable future.

e. Cost Justification

It was stated that the management direction toward decentralization and downsizing has not been prompted by any thorough analysis or cost justification. "It wasn't even a seat of the pants judgment, it was more like a gut reaction..." was the way one interviewee described the decision to move toward downsizing and client/server architecture. There is currently no unanimous agreement that downsizing will be cost justified; it has been prompted by "...what some people have read in the trade press."

IS, confronted with the "dispersal" of personnel resources to user departments, and sensitive to the technological innovations that are shaping information systems infrastructures of the 1990s, decided that it was necessary to define a long-range information architecture for the university—something that would extend well beyond the year 2000.

2. Implementation

Recognizing the complexity of developing the long-range information architecture, the IS department was prepared to spend a substantial amount of money for consulting services to help in the initial definition. In late 1990, a comprehensive RFP (which emphasized the existing IS infrastructure) was prepared and two proposals were received from major consulting firms. A year ago, it was determined that neither proposal demonstrated that such consulting would be of substantive assistance in defining and implementing the information architecture. (And the price tag for any political assistance that might have been afforded by having an outside consultant involved was too high.)

Therefore, it was decided that the design and development of the interim information systems architecture would be accomplished employing university resources under the direction of the "CIO." One of the primary objectives will be to establish policies and standards (even though past experience indicates enforcement will be difficult). Preliminary to the establishment of a permanent implementation team, various task forces were established to address such issues as migration, interoperability, and cost and funding. In this report, INPUT will concentrate on the work of the Cost and Funding Task Force.

3. The Cost and Funding Task Force

a. Purpose of the Task Force

The purpose of the Cost and Funding Task Force was to examine and identify appropriate methodologies, processes and resources to determine the financial feasibility and advantages to the institution of moving to a new information systems architecture. The task force was informed that the primary financial goal of new architecture will be to facilitate the purchase and installation of off-the-shelf commercial software applications that have the following characteristics and benefits:

- The “applications” will reside on either distributed (LAN) or mainframe (central) platforms, and will be interoperable.
- They will have the benefit of avoiding “costly in-house application development and maintenance.”
- They will provide the university staff with improved access to “institutional data.”

This statement of purpose to the task force provides insight into the motivation behind the management directives to “disperse” IS personnel to user departments, and to downsize to a client/server environment. It is obvious that management has not been pleased with the cost of applications development, and users have not been pleased with access to institutional data resources.

The task force, having been charged with the responsibility for doing a preliminary cost/benefit analysis of moving to the new architecture, made some “important and fundamental assumptions” during the course of its working sessions.

b. Assumptions

The following are the assumptions of the Cost and Funding Task Force, with INPUT’s comments as appropriate:

- A “data warehouse” will be created within the institution, and it will be managed by the central data center. (This is a necessary and convenient assumption for the Cost and Funding Task Force that leaves open the question of the existing in-house-developed DBMS and its data bases. Presumably the other task forces will have to determine whether, how, and when to shift data bases.)
- Local hardware (such as workstations and printers) will be the responsibility of the individual departments and will comply with institutional policy on supported platforms. (The data center currently provides terminal support for a wide variety of platforms and devices.)
- LANs will be a responsibility of the departments in terms of both cost and technical support. (INPUT doubts whether the technical support portion of this assumption will survive review and/or actual practice—the user departments have been too accustomed to excellent campus networking support.)
- An institutional policy will be enacted to limit the number of hardware/software platforms for which application tools will be developed.
- Data integrity, security and authentication will be the responsibility of the centralized data center and network communications services.

c. The Cost Model

Based on the above assumptions, the task force developed a comprehensive cost matrix (shown in Exhibit IV-1) that compared a campus client/server architecture with the existing central mainframe environment.

EXHIBIT IV-1

Downsizing Cost Factors

Cost Factors	Data Center	Network Services	Application Custodian	End User
<i>Application Support</i>				
Development	Neutral	Neutral	Minus (1)	Neutral
Maintenance	Neutral	Neutral	Minus (2)	Neutral
Documentation	Neutral (3)	Plus	Neutral	Neutral
Training	Neutral	Neutral	Plus	Neutral
<i>Hardware</i>				
LANs	Neutral	Neutral	Plus (4)	
Workstations	Neutral (6)	Neutral	Neutral	Plus (5)
Servers	Minus (7)	Neutral	Neutral	Neutral
Network Backbone	Neutral	Plus (8)	Neutral	Neutral
Environmentals	Minus	Neutral	Neutral	Plus
<i>Systems Support</i>				
Data Quality	Plus (10)	Plus (9)	Plus	Neutral
Standards	Minus	Minus	Minus	Minus
Systems Software	Plus (11)	Neutral	Plus	Neutral
<i>Staffing</i>				
Staffing Levels	Neutral	Plus	Minus	Minus
Local Expertise	Neutral	Neutral	Neutral	Plus
<i>Transition Costs</i>	Plus (12)	Plus	Plus	Plus

The various cells in the matrix indicate whether the Cost and Funding Task Force felt that a client/server architecture would result in increased (plus), decreased (minus), or approximately the same (neutral) base expenditures than the existing mainframe-oriented architecture.

These judgments obviously depend upon the task group's knowledge of current expenditures and their expectations of the client/server architecture. However, they are also heavily dependent upon individual perceptions of the value of current information systems and services. For that reason, it is not surprising that the five members of the Cost and Funding Task Force did not always see eye to eye on even these rough estimates of the cost benefits of downsizing. These initial evaluations may be viewed as the development of a more detailed set of assumptions that will require continuing refinement as the process of developing an information systems architecture proceeds.

The following "notes" (or qualifications) were provided by the task force for the most "significant cost components," and they illustrate the preliminary and tentative nature of the cost/benefit analysis.

(1) The Cost and Funding Task Force was told that one of the primary financial goals of the new information systems architecture was to "avoid costly in-house development," and the task force dutifully indicates that applications development cost will go down. However, the following is a summary of the lengthy note of qualification that was attached to the matrix (on the preliminary report of the task force) with INPUT's comments as appropriate.

- "The marketplace will be providing a much richer environment of tools to assist the full range of the development process, and once the learning curve problems are met, we will find that the development process will be cheaper and faster." (This is obviously an assumption that CASE, GUIs, packaged applications, etc. will be superior to the current development environment at the university.)
- "This means that in the near term (2-3 years) we will be climbing a learning curve, and applications development tools will not yet be able to overcome the lost productivity..."
- "Since some of these same tools could be used...whether the system is mainframe or client/server...we will not increase our productivity over the mainframe development environment." (Downsizing and client/server architecture may not be directly related to achieving the goal of more cost-effective systems development.)

- “We will have whole new areas of security, integrity, recoverability, language standards...which we will need to learn, develop and manage before turning the ‘benefits’ corner.” (In other words, don’t hold your breath waiting for the benefits of downsizing to materialize.)

(2) The task force was more optimistic about the benefits associated with applications maintenance in the client/server environment, but even here it is qualified by stating that this will be due to the fact that “...we will not be investing in this on the mainframe side...” Then, it was stated that expert systems “...will also start to come into play for use in maintenance...over time.” (Systems maintenance—both hardware and software—has been a designated target of opportunity for artificial intelligence for a long time, and it is INPUT’s considered opinion that applications maintenance in a decentralized environment will actually become more complex. In fact, this has actually been confirmed to a certain degree because the IS personnel that have been “dispersed” to user departments have less time available for development work.)

(3) The reduced costs of documentation for internally developed systems software (DBMS, electronic mail, calendaring, etc.) will be offset by continuing (and perhaps increased) costs for documenting new services, standards and preferred programming practices in the client/server environment.

(4) Since an initial assumption was made that users would bear the expense of LANs (including technical support), it is only natural that there will be an increased cost to end users. The task force notes that:

- “As departments move to the new client/server architecture, there will be heavy demands for installing more sophisticated local-area networks to take advantage of the productivity improvements of the new architecture.” (It should be noted that end-user staffing levels are being lowered in anticipation of this improvement in productivity, but the anticipated—and promised—white-collar productivity gains associated with personal computers failed to materialize in the 1980s.)
- “This (the user investment in new LAN technologies) will mean increased cost for network hardware, software, and the expertise to support the networked environment.” (See the note on this item under the Assumptions section above. INPUT does not know whether the central IS function is playing political games here, but when asked about vendor support for the emerging downsizing technologies, the reply was: “It stinks.” It is possible that the central function wants to give end users a taste of reality.)

(5) The task force notes that there will be a significant increase in costs to the institution as the result of upgrading end-user workstations in order to “...be able to handle the processing and data manipulation requirements of the client/server environment.” An

estimate is given that the minimum configuration (for example, for a Macintosh IIfx) will cost “about \$4,000 per station” and when that is totaled up for the institution it may represent the highest increased cost associated with the new information architecture. (Just as systems software has been more than up to the task of “keeping the mainframe busy,” count on the operating systems needed to support image processing, GUIs and multimedia to be able to gobble all those cheap MIPS we keep hearing about.)

(6) Even though the cost of workstations in the central IS function (the Data Center) is projected to remain essentially the same, the task force saw fit to add a note stating that the “increases in costs will occur” just “as with all other departments and offices.” (The only reason we can think of for the “neutral” rating is that recent upgrading of workstations in the IS function probably means they will not have to upgrade in the near term, and they have probably always stayed ahead of the end users. Therefore, client/server won’t make that much difference.)

(7) Here is the way the decreased cost of data center servers is rationalized (as well as qualified). Follow this one closely—it is at the heart of the cost justification for downsizing from mainframes.

- The note starts by stating that there will be “a significant increase in the costs of server hardware.” (Remember that despite the best efforts to downsize, the mainframe will probably go through two major upgrades, and the mainframe is viewed as a central server in the new architecture.)
- “Many functions now bundled on the mainframe will be provided on servers...these servers will need to be purchased.” (While the mainframe stays installed.)
- “This cost increase will be partially offset by a gradual decrease in the cost of mainframe hardware.” (“Partially offset” and “gradual decrease” certainly qualify the hardware cost benefits that are being anticipated from downsizing.)
- Then, finally, it is stated that: “As the mainframe’s role decreases...the size (and therefore cost) should decrease also.” (One gets the impression that the task force has some severe reservations about the ability to decrease hardware costs by installing the client/server architecture—at least for a number of years. To support this “minus” evaluation, one must certainly take a long-range view.)

(8) The university has already spent millions of dollars on the campus network and has gone through a period of some embarrassment because maintenance costs were not properly estimated in the original cost justification. However, the backbone network

is certainly more advanced than most that are currently installed among even large commercial users. The task force has concluded that:

- “...more large packets of data will travel over the network, requiring greater bandwidth.”
- “Under the client/server model, the network will have to become a production level system with increased reliability, availability and support.”
- Then, because the network is critical to the client/server environment, “...we will have to make increased investments in training, documentation and consulting support.” (The net result of all this is that even with a relatively advanced communications infrastructure, client/server computing requires additional investment.)

(9) The network will be required to provide authentication and security services in addition to those currently provided on the mainframe system. This will require a network or “data warehouse,” “security servers,” and a full level of maintenance and support by network services. (Remember, the assumption was made that the data center and network services would share responsibility for data quality in the client/server environment.)

(10) The task force notes that to maintain data quality will require a “major increase in cost” for the data center because “distributing data will increase administrative costs of managing the data and the tools to access the data.” (While it wasn’t specifically noted, the university will probably find itself with all the complexity—and expense—that is characteristic of many large IBM mainframe shops that have a complex IMS/CICS/DB2 type of DBMS environment. Certainly the in-house-developed DBMS isn’t going away overnight, and the university has already installed DB2 in anticipation of needing a relational DBMS at the mainframe level. The problems of data base management increase dramatically from an environment where use of a single, centralized DBMS was the foundation of all commercial development work.)

(11) Systems software will represent a “significant increase in costs” to the data center even if the mainframe doesn’t grow. This problem is compounded by the fact that the university has done so much of its own systems programming work. Now the university must get mainframe software licenses to support the client/server environment at all three levels (mainframe server, distributed server, and client).

(12) That brings us to the question of transition costs. Here is what the task force had to say about that subject: “Major institutional cost (one-time, although for many years); we will need to support and operate in a dual architecture environment—both mainframe and client/server—for many years.” (And it should be pointed out that during those “many years” there will be increased costs across the board.)

The university has already determined that there will never be payback on converting certain applications because they will not endure long enough to pay back their transition costs. On the other hand, it is extremely expensive to be caught halfway between old and new information architectures. We do not envy CIOs who are confronted with comparable problems, but they are certainly better off than those who are not aware that the problems exist.

What do all of the pluses and minuses mean?

That is the question raised by the director responsible for developing the university’s long-range information architecture. It is a good question, and it is obvious that the work of the Cost and Funding Task Force (or the follow-on permanent team) is far from complete. However, the Task Force’s report is an extremely important and useful document.

- It provides a way of thinking about the broader cost ramifications of downsizing that go well beyond the relative cost of MIPS on a RISC workstation and an IBM mainframe.
- It also isolates critical factors that must be analyzed and played off against each other to determine the net impact of downsizing. For example:
 - Will the decreases in application development costs actually be realized? Or will those involved merely be confronted with a replay of the 4GL saga on a new platform and in a new environment?
 - Even if these benefits do materialize, will they be more than offset by the increased costs necessary to maintain data quality? Or will data base integrity be sacrificed because of quick-and-dirty application development?
 - Will transition costs become a critical drain on both human and financial resources, and adversely impact the necessary maintenance of mission-critical applications? Or, worse yet, will we get 90% of the way through the distribution of data bases only to find that the last 10% seem to require maintenance of full corporate data bases stretching seamlessly into perpetuity?

INPUT will assess the critical factors and provide a framework for balancing of pluses and minuses when it analyzes the case studies and simplifies the cost model later in this report. However, the Cost and Funding Task Force provided INPUT with additional value by recommending some strategies for implementing the move to a downsized client/server architecture.

d. Recommended Strategies

Questions involving funding and cost recovery become prominent as soon as information technology is shared. These questions were raised starting with simple timesharing systems; they led to extensive system management facilities for purposes of billing, and capacity and performance planning on mainframe computers; and their importance extends to the “production network” that will result from the new information systems architecture being implemented at the case study university.

The recommended strategies from the Cost and Funding Task Force address these issues, and this is especially commendable, because many otherwise responsible IS managers feel that computer technology is becoming so cheap that it isn’t worthwhile to worry too much about cost justification or accounting for its use.

The following is a brief summary of the recommended strategies:

- Existing workstations will only be replaced at the end of their useful life and not by a mass upgrade. Where more powerful hardware is required by a client/server application, the cost should be included in the development costs. (This will tend to reduce application development cost savings, but it will be a more accurate assessment of the true costs.)
- It is also recommended that staff productivity savings be applied to fund departmental hardware and LAN costs. (This will bootstrap the implementation of the new client/server architecture, but it also implies specific cost justification.)
- It is recommended that applications built on the in-house DBMS be replaced only when there is a business purpose for doing so; but new applications should be developed in client/server architecture. (Presumably, the in-house DBMS could be employed for client/server applications if it is deemed appropriate. Certainly some type of pair-wise connectivity will be required between the in-house DBMS and many client/server applications.)
- Include incremental costs of the “production network” in application development projects for the purpose of network funding.

- Funding sources should be interchangeable across the mainframe and client/server architectures, and the source of funds should not become an issue when deciding which architecture to use for developing a new system. (File and data base servers supplied on the network should be reasonably transparent to systems developers, but presumably some LAN servers could be the responsibility of the user department.)
- Cost recovery mechanisms should be consistent between the two architectures, and capacity of platform should not be a cost consideration when developing client/server applications. (In other words, the user should not be concerned about where data being managed by the data center resides.)

One thought expressed about cost recovery that did not appear in the task force report is especially intriguing. Rather than use a conventional billing algorithm, it has been suggested that clients be billed primarily on the basis of data storage, data access, and data distribution. (Essentially, deemphasizing processing cycles and emphasizing the value added by the data base server in terms of data base integrity, synchronization, and security.)

Using a broad definition of data (anything stored in a computer), and properly constructed, such a billing scheme would have many advantages in encouraging proper data base design and use of server resources. In addition, the end result would be to assign value to data and link it closely with its end use. This would go a long way toward identifying, classifying, and managing data in our computers; and would provide a solid foundation for identifying valuable information that has been lost among data.

In the other downsizing case studies, INPUT will apply the cost model to isolate the issues with which other organizations are struggling.

B

Case Study #2—Rightsizing the Information Architecture

1. Background

This case study company is a major railroad that:

- Could be considered IBM's first customer because it tested early punch-card equipment for IBM's predecessor
- Had a communications network before there was a telephone company, and installed what was once the world's largest private microwave network

- At one point about thirty years ago, had a radical computer group in the operating department that decided to develop all of its own systems software with the following results:
 - The human and machine time devoted to program development on an IBM mainframe was reduced by more than an order of magnitude.
 - The operating department was able to select its own mainframe computer without regard for vendor supplied systems software and support; but when it did so, the Brand X computer vendor had serious hardware problems and couldn't deliver on time.
 - It then promptly installed an IBM mainframe of radically different architecture from the one it had been using without the "benefit" of any IBM systems software or systems engineering support.
- Specified and installed the first IBM computer terminals before they were an announced product.
- Used high-speed xerography for transmission of paper documents and data capture in the 1960s.
- Went heavily into distributed processing (downsizing) in the 1970s by installing an extensive network of Data General minicomputers.
- Enhanced the network with personal computers in the 1980s.
- Is now installing Tandem image processing systems that will eventually change the information architecture of the company once again.

In other words, the railroad has generally been on the leading edge of information technology innovation.

However, management at the railroad feels that it is trapped on IBM mainframes with expensive, proprietary systems software; and it has difficulty understanding how the company ever got itself in this unfortunate position.

2. The Mainframe Trap

What management doesn't understand is that the railroad got where it is today because the IS department decided to do everything "right." It was decided in the mid-1960s that it was ridiculous to develop systems software, when it was available "free" from IBM. Then the company standardized on COBOL, which was supposed to solve ease-of-use and portability problems for all time. With programs written in English language, executives were going to be able to read them and find out what was going on in the IS department; and, by having a common business-oriented language supported by all vendors, users would become vendor independent.

What seemed like a good idea at the time obviously didn't turn out that way, or the company wouldn't be concerned about the expense of IBM systems software, and executives wouldn't have to be asking the IS department why the "investment" in COBOL programs is the primary reason the company will remain trapped on mainframes for the foreseeable future.

The early expectations for COBOL may seem naive now, but for those who have been around for awhile, there is striking similarity to current UNIX enthusiasm—including the strong support from the Department of Defense.

The current VP of IS at the railroad was a young computer engineer in the maverick group that believed in developing its own systems software, so he saw the mainframe software trap being baited and sprung. He has made every effort to "rightsize" independently of the direction set by IBM, and he has employed competitive hardware and software over the years, but he finds himself and his company firmly locked into IBM's proprietary systems software.

a. Systems Software Is No Longer "Free"

The factors prompting discontent with mainframe technology on the railroad are specifically related to the expense of mainframe systems software. The cost of outside software is currently about \$3 million a year and equally split between IBM and other vendors. The frustration with software expense manifested itself during INPUT's interview with the VP of IS, and it arises from several sources.

- The document-handling software for the Tandem image processing system represents a continuing expense, and it was stated that the only solution might be to "get the source code and maintain it ourselves."
- A mainframe upgrade from a Model 400 to Model 600 resulted in the cost of mainframe systems software increasing enough to become a topic for management discussion. The VP of IS still remembers the pressure IBM applied to his management to accept its "free" systems software many years ago when he was still a young systems programmer. He also knows how much that small, highly skilled team accomplished, and this makes it all the more difficult to rationalize the current systems software trap.
- He finds it is extremely difficult to explain to his management why the price for the same software keeps escalating every time they upgrade their hardware.

- Then, senior management (and even the board of directors) wants to know how they ever got themselves in a position of not having alternative sources of supply for IBM systems software. When he tries to explain how that happened “they just don’t understand.”
- He stated that he can understand IBM’s position because “they are in business, too”—but he wishes he had an alternative to IBM systems software. He thought at one time that EDS and Hitachi might come up with an alternative to IBM operating systems, but then he remembered the settlement of IBM’s suit against Fujitsu and realized that there isn’t much possibility of any real alternative to IBM operating systems becoming available.
- He mused that perhaps they were right 30 years ago when they developed all their own systems software in the operating department, but it seems obvious that this is not a viable solution to the current problem. (The systems software trap was baited with “free” software 30 years ago and once the bait was taken and the unbundling trap was sprung, there has been no escaping for IBM mainframe customers.)
- Over the years, the railroad attempted to maintain as much freedom as it could, but that hasn’t helped very much either. The railroad installed IDMS in lieu of IMS when they installed a DBMS, and now that represents a significant portion of the \$1.5 million a year of non-IBM software expense.

It all adds up to the fact that mainframe systems software (which was designed to keep mainframes busy) is now expensive enough to attract the attention of senior management. One of the directors of the railroad is president of another organization that discarded its mainframe in favor of IBM AS/400s, and he mentioned that this downsizing effort is working out quite well. When this level of computer literacy sneaks into the board room, IS management is under constant pressure to consider alternatives to perceived problems such as mainframe software expense. Published information concerning downsizing and open systems are the stones being thrown at the mainframe glass house—what has been going on in there is becoming increasingly apparent.

The railroad isn’t thinking so much about downsizing as a strategy; it has been attempting to use computer technology at proper levels for years. It is thinking about how to get out of the mainframe software trap, and that is not going to be easy.

b. The Nature of the Trap

One of the primary factors inhibiting the railroad from downsizing is its 30-year “investment” in COBOL programming. The railroad’s initial decision to go COBOL was strongly influenced by some of those in the IS

management hierarchy who had experience in the Air Force, which was then one of the strongest COBOL proponents. They honestly believed all of the wonderful claims that were being made for COBOL at that time.

Unfortunately, by the early 1980s, a major government-sponsored study was projecting that because of "...the current use of FORTRAN and COBOL...the U.S. will have a national inventory of unstructured, hard-to-maintain, impossible-to-replace, programs..." threatening to confront us with a "...software gap more serious than the missile gap of some years ago." [22] Those early believers in COBOL, such as the railroad, now find themselves in precisely that position, and they aren't terribly impressed when the Air Force and other government agencies start making the same promises for UNIX and C.

The railroad also has an extensive investment in IDMS. It was expensive to convert to a DBMS in the first place. One respondent to an INPUT research project, when asked about the cost of converting to a DBMS, said, "We don't know, and I don't think we want to know." Now these large central data bases are in place, and it will be even more expensive to convert them to a radically new, downsized information architecture. In fact, it is doubtful whether some of them will ever be converted—abolished maybe, converted no!

The factors currently inhibiting downsizing are directly related to the railroad's actual experience with transferring responsibility for data quality to operating management. This experience is worth reviewing.

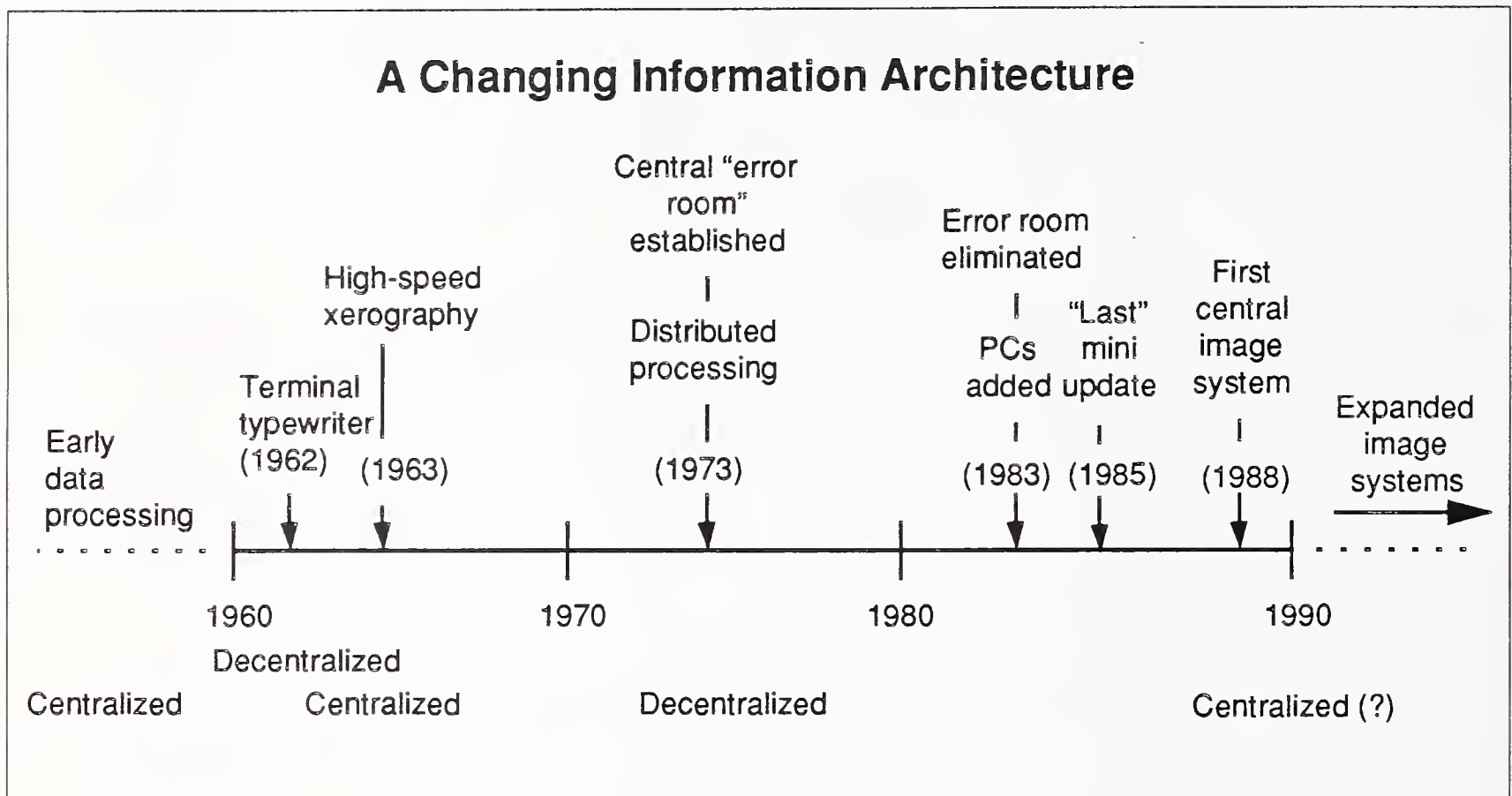
3. Information Architecture and Data Quality

Railroading has always been an information-intensive business. Railroads must account for their use of equipment from other railroads and private line car owners, and pay for the use of these cars on a per diem or mileage basis. They also must be able to bill shippers, other railroads, and forwarding agents based on complex rate schedules for various goods and commodities that are shipped over their lines. And—of primary importance—they must be able to distribute equipment and track shipments in order to be of service to their customers.

The subject railroad has attempted to use information technology to gain competitive advantage by providing advanced services to customers, some of whom use the railroad as an extension of their assembly lines and as the replacement for parts warehouses. Success depends on high-quality, timely information as much as it does on efficient operation of the railroad system.

Over the years, the railroad has adopted various information architectures depending upon the availability of information technology and, more importantly, the need to maintain data quality. This has resulted in the cycles of centralization and decentralization summarized in Exhibit IV-2.

EXHIBIT IV-2



a. Early Data Processing—Centralized

As mentioned earlier, the railroad was an early innovator in the use of unit record (punch-card) equipment. Paper documents arrived at a central data processing facility through the mail (which was usually delivered by train), and data was entered (keypunched) from these documents and verified under close supervision. There were nearly 100 keypunch operators, and each card contained a keypunch operator code used for both qualitative and quantitative performance evaluation of the individual operator.

These card decks represented the data bases of the centralized data processing facility, which until the advent of computers consisted of punch-card equipment that sorted, collated, tabulated, and printed all necessary documents. Card decks were exchanged with other railroads to account for use of equipment.

With the advent of computers in the 1950s, card images were transferred to magnetic tapes, which then became the data base, and computers then sorted, collated, computed and printed reports. Magnetic tapes and/or card decks were exchanged with other railroads depending upon their current state of automation. (EBCDIC worked just fine before ASCII.)

Since it was after the fact, this highly centralized environment resulted in high-quality but not very timely data on the movement of equipment and shipments over the railroad. It was essentially a computerized unit record operation—just as most commercial data processing operations were in the 1950s and 1960s.

b. Downsizing Data Entry With “Terminal Typewriters”

In the early 1960s, a maverick group of computer engineers in the operating department justified having their own computer for the control, distribution and reporting of car movements on the railroad. In order to distribute equipment (and provide customers with better service) it was necessary to obtain more timely data.

The “terminal typewriters” were designed and named with great care because there was a jurisdictional dispute between railroad clerks and telegraphers about the work of reporting car movement information. They were installed at points of interchange with other railroads and at yards throughout the railroad system. They were relatively crude devices that captured essential car movement information as a yard clerk typed a switch list, and they produced a punch card at the other end. The cards then entered the computerized unit record operation described above.

This decentralized operation effectively “downsized” the central keypunch facility where operators were subjected to rigid quality control. The yard clerks, on the other hand, worked in a rough-and-tumble environment where the primary emphasis was on putting trains together, and few of them even had the advantage of being touch typists. Several problems developed with this operation almost immediately:

- Having one bad character in the initial or car number of a freight car or a station number doesn’t usually matter when switching cars because this is close enough for the humans involved. However, it does matter to a computer, and the messy switch lists of the past had to be improved to “office quality” practically overnight. This wasn’t easy, especially since some of the yard personnel felt that the computer might eventually eliminate their jobs.
- In addition, when IBM designed the terminal typewriter, it did not see fit to distinguish between an O and a 0 on hard copy (a problem it also had on some of its printers in those days). Either intentionally or unintentionally, Os started appearing in car numbers on the incoming data. Even though the computer was able to correct these mistakes quite easily, all such errors were reported back to the yards for correction, strengthening the opinion that the computer was “watching” what was going on. This worked reasonably well because fear was a traditional means of motivation in railroad yards.

With continual monitoring and management pressure, data capture through the terminal typewriters proved adequate for simple car movement information. However, the operating and accounting department computer operations were integrated shortly after the terminal typewriters were installed in 1962, and the more detailed waybill information required for accounting applications proved to be beyond the capacity of the terminal typewriters and the capability of the yard clerks. It was simply impossible to maintain data quality in the decentralized environment.

c. Early Image Processing and Recentralization of Data Entry

In 1963, it was decided that data quality could be improved by recentralizing the data entry functions; in order to speed the process, paper documents were transmitted from various points around the railroad to a central data entry facility using high-speed xerography. This was technically and economically made possible by the fact that the railroad had by then installed the world's largest private microwave network.

Once the documents were received at the central location, terminals attached to mainframes could be employed to improve the data entry operation. Skilled data entry personnel and centralized quality control could now be accomplished in a more timely fashion, and central data bases now resided on direct access storage devices. The days of running a computerized unit record shop were over.

The improved information flow achieved by this early image processing (or at least transmission) system provided timely tracking of both trains and individual shipments, thus improving both railroad operations and customer service. This system lasted for 10 years—a virtual millennium by today's standards!

d. Downsizing with Distributed Processing

By 1973, advances in minicomputer technology made it economically and technically attractive to distribute both data entry and operating document preparation back out into the yards where everyone thought it belonged. The railroad proceeded to install an extensive network of Data General minicomputers and terminals, and operating applications were downsized from an IBM mainframe to those platforms. Some of the same data quality problems experienced with the early installation of the terminal typewriters reappeared.

- Information sufficient to “run the railroad” did not always produce data of high enough quality to satisfy accounting and customer service requirements.
- A central “error room” was established at the central computer facility to maintain data quality. The error room was staffed with five people and their job was to identify errors, and get the operating department to correct them.

- This did not work very well because “running the railroad” always took priority over submitting (or resubmitting) data for the central computer operation—regardless of whether these data were necessary for proper billing or customer service. IS management sincerely felt data should be captured (and corrected) as close to the source as possible even though it was sympathetic to the operating problems out on the line of road.
- Although IS management felt the “error room” was expensive and not working as well as IS would have liked, it continued in operation until 1983.

During this period of downsizing, the central mainframe installation continued to grow. The railroad became a major user of IBM’s Mass Storage System (a magnetic cartridge-based, low-cost storage system that was eventually replaced as magnetic disk costs continued to decrease) in order to accommodate growing corporate data bases, and mainframe computers continued to increase in size to support “advances” in operating systems and data base management technology.

e. Personal Computers Appear

When personal computers were just beginning to penetrate the corporate environment in the early 1980s, INPUT interviewed the railroad’s Vice President of IS, and his position was that he would release “his data” to other departments if management told him to do so, but that nothing would get into his data bases unless processed by mainframe applications. He also made the statement that printers used by personal computers should be “hardwired” to print out “The IS Department Did Not Prepare this Report.” One can sense that the struggle over control of data and the responsibility for information quality had already been joined on the railroad.

Nonetheless, at about this time (1983), it was decided that the error room would be abolished because it was “expensive”; the problems of data quality (and correction) would be turned over to the transportation department. This was justified because considerable investment was being made in additional processing power on the desktop, and with “computer literacy” it was felt that users should become more sensitive to problems of data quality.

During the research for this downsizing study, INPUT asked the VP of IS how this had worked out, and he said: “The situation just got a lot worse. They (the transportation department) just don’t have very much incentive to maintain data quality. I guess I made a mistake.”

Perhaps it wasn’t a mistake, but merely an accurate representation of reality. INPUT’s earlier research on downsizing showed that 50% of IS management believed that some responsibility for “data and/or management information quality” would be transferred to users, but only 22% of

vendor management agreed with this assessment. However, when this same issue was slightly restated to the effect that data base management responsibility would be transferred to users, the results were reversed, with only 29% of IS management agreeing compared to 50% of vendor management. [2] (The important issues of information quality and data base management responsibility will be analyzed later.)

f. Downsizing, Upsizing and Rightsizing

What was referred to as the "last upgrade" of the distributed minicomputer network was made in 1984-1985. The feeling that minicomputer architecture is "dead" (at least on the railroad) is due to development of PC LANs, and also to the fact that the fundamental information architecture of the railroad is being re-engineered once again.

- Although it is becoming apparent that PC LANs in a client/server architecture are more cost effective for many of the functions previously performed on minicomputers, it is also apparent that persistent problems of data quality are not necessarily going to be solved by downsizing to a lower level. Therefore, concurrent with the downsizing of minicomputers to PC/LANs, upsizing to centralized systems for data capture is being initiated.
- The fundamental information flow on the railroad is being re-engineered employing image processing systems that will capture and process the actual bill of lading, thus permitting the preparation of both operating and accounting documents (such as waybills and accounts receivable). One Tandem image processing system servicing 70 remote locations has already been installed, and it is anticipated that "three or four" could eliminate the minicomputer network and also significantly reduce mainframe processing. The current thinking is to run all bills of lading through the image processing system regardless of whether they are received on paper or electronic media.

This review has covered over 30 years of what is essentially the same information system. The information architecture has fluctuated depending upon available technology and the impacts of those technologies on the quality of data and management information. The telescoping of several decades makes those innovations appear to be erratic, but they clearly display new technologies prompting innovations that are, in turn, impacted by the human side of the systems equation.

Despite all of these changes, a top-level flow chart of the overall railroad information system would reveal that the same general structure has been in existence since "data processing" consisted of hand preparation of paper documents and telegraphy was the latest innovation in communications. It is important to put current information technology into historical perspective.

The current direction toward image processing represents:

- An upsizing of currently installed minicomputers to fewer, more powerful processors
- The downsizing of some former minicomputer functions to PC LANs
- The downsizing of some mainframe applications to the image processing systems
- The recentralization of some data base management responsibilities formerly distributed to minicomputers
- The decentralization of some data base management functions formerly centralized on mainframes

It is obvious that the information architecture can shift in both directions at the same time, and the railroad does not currently foresee the time when mainframes will disappear. They will remain as data base servers well into the next century. What is happening right now on the railroad can quite properly be classified as just another phase in a continuing effort to "rightsize." However, there is no question that at this point in time there is considerable impetus to change the mainframe environment.

A new environment prevails in the information age, and it is related to the people side of the total information system.

g. The Human Side of Downsizing and Empowerment

Though we have already touched on the human side of the data quality problem, it is more complex than has been portrayed. In addition to the problems associated with the skills and motivation of operating personnel to maintain data quality of data bases not directly related to their day-to-day work, there are other factors:

- Some operating personnel try to beat the system in order to enhance their own performance (or at least avoid detection of poor performance).
- Other operating personnel use the system to avoid responsibility.
- Whenever data are distributed, internal power struggles develop over the use of the data. The struggle between operating management and "bean counters" is traditional on the railroad.
- Empowering end users with computer power and data can lead to even more pressing problems. It was stated that some freight agents "...try to steal us blind. If they can save a buck they will tell us they are shipping tricycles when they are shipping bicycles."

It should be clear that data quality and use circumscribes the railroad's use of information technology.

4. Function and Application Selection for Downsizing

The "ancient history" that has been reviewed clearly illustrates the fact that downsizing (or empowerment) has been directed toward two primary elements of the total information system—data capture (input) and data display (output). The railroad's experience demonstrates that commonly accepted wisdom about capturing data as close to the source as possible, and providing ready access to data may have adverse as well as beneficial consequences over the long term (or in specific instances).

a. Data, Data Everywhere and Still No Solution

The impetus to downsize comes from mainframe expense, which continues to grow despite two decades of pushing processing power outward in the network. Applications are selected for downsizing based on their ability to offload the mainframe. For example, the need for a car distribution application, which was the primary justification for the operating department ordering its own computer 30 years ago, now runs on a Sun workstation because it is a compute-intensive application. This downsized application provides an important example of the limitations of information technology.

- While the car distribution "application" has been moved to a workstation, much of the mainframe growth on the railroad over the last 30 years has been required to provide the data base necessary to support that application. (The car distribution application has to "know" where all cars are in order to distribute them, and only the mainframe "knows.")
- A few years ago *Business Week*, in an article on artificial intelligence (expert systems), stated that the railroad was using AI to distribute equipment. INPUT called the VP of IS and asked him about this application. He stated that he wasn't sure exactly what people meant when they talked about AI, but he knew that this particular application was strictly linear programming. He stated that it was valuable primarily for training purposes when moving personnel from one work location to another.
- When INPUT found that the car distribution application had been downsized to a workstation during the research for this case study, it inquired of the VP again, and he stated: "It is not one of our better applications."

- What started out as a relatively “simple” application 30 years ago continues to defy the best efforts of experts in both operations research and AI. Why? Because car distribution is a data base problem and not a processing problem.
- It turns out that it isn’t simply a matter of knowing which cars are empty and minimizing mileage to either get them to their next load or, in the case of foreign cars, off-line where you don’t have to pay for their use. Several problems arise with this rolling inventory of equipment that make data base management rather difficult:
 - The condition of cars can change based on the last load.
 - The condition of cars changes because of minor accidents in loading or unloading.
 - The computer can’t anticipate random changes in customer car orders or “understand” the individual customer’s standards for equipment acceptance or rejection.
 - In other words, the human element comes into play at some level in servicing individual customers, and new information systems require increasingly detailed data to be reported.
 - This, in turn, means that even essential operating data may suffer in terms of quality.
 - Improved hardware price/performance does not solve problems of increasing data base (or knowledge base) size and complexity.
- The car distribution problem is a good example of the big bang theory of systems development—a theory that assumes that if we just have enough data we can solve all planning, forecasting and control problems. Thirty years of history and considerable expense demonstrate that this is not necessarily the case.

b. Experience Has No Substitute

The railroads experience clearly demonstrates the following:

- Any mainframe application can theoretically be run more cost effectively on a downsized platform—provided it has ready access to data.
- Current mainframes are necessary only to run complex operating systems and to manage large data bases.

- The expense of the systems software to drive large mainframes—in terms of both processing power required and customer out-of-pocket expenses—is highly visible and appears indefensible when compared with that on downsized platforms.
- Therefore, application (or function) selection should be relatively simple—merely offload everything and eliminate the mainframe; or, at the very least, reduce it as rapidly as possible to a central data base machine.
- However, in actual practice, it has been found that downsizing (for any number of reasons) hits limits in terms of data quality and tends to bounce back up again.
- Therefore, experience shows that applications and functions should be downsized from mainframes based on the impact on data quality; or, more specifically, the ability to manage distributed data bases on a wide-area network.

The VP of IS says that he firmly believes that there is a proper hierarchy of data storage, and that it can be managed. However, he has no illusions that this will be easy. The evolving information architecture will require re-engineering of those old COBOL programs, and the effective management of distributed data bases will require new, complex tools (such as object-oriented programming and repositories).

5. Downsizing Results

The railroad has been remarkably adept in the effective application of technology. It was among the first to eliminate firemen from diesel locomotives. Early computer applications were specifically designed to eliminate unnecessary clerical expenses. Despite hitting the data quality “wall” on several occasions, the railroad has continued to pursue the effective use of the latest information technology, and it has remained profitable during times when other railroads have faced bankruptcy.

Since the subject railroad merged with another in 1982, the combined headcount of the two railroads has gone from approximately 42,000 to 27,000. Car loadings during that time have not declined significantly, and most of this personnel downsizing can be directly attributable to the effective application of information technology. Since this period coincides with the personal computer revolution, it can be safely assumed that microprocessor technology was a factor in the improved productivity of the remaining workers.

However, the VP of IS states that perhaps downsizing has gone too rapidly: "Service to customers has declined, and they are letting us know about it." Keeping technological and organizational downsizing properly synchronized will remain a critical consideration in the 1990s. The critical cells in the university's "cost model" provide a convenient framework for analyzing the major issues associated with the railroad's downsizing efforts.

6. The Downsizing Cost Model

The railroad has been running essentially the same applications for the last 30 years. From the early days of computers, information technology has been directly involved in the process of railroading. During that time, the price/performance of mainframe computers has improved by over two orders of magnitude [23] and every effort has been made to take advantage of distributed processing, advanced networking, and new hardware architectures (minicomputers, PCs and RISC-based workstations), but the railroad finds itself with constantly escalating expenses for mainframe hardware/software.

When the cost model developed by the university is applied with awareness of the railroad's history, current situation, and expectations from downsizing, it is possible to obtain some valuable insights about management's role in the application of information technology, and how the focus has changed over the years.

Exhibit IV-3 identifies the most significant cells in the downsizing cost factor matrix; the following examines them by column.

a. The Data Center

(1) Corporate mainframes are a highly visible expense, and it is becoming increasingly difficult to rationalize the fact that fundamental accounting applications that used to run on an IBM 705 thirty years ago now run on an IBM 3090, Model 600, while school children routinely play with computers that have over one thousand times the raw processing power of the 705. The railroad's objective in downsizing is to offload as much processing as possible to the more cost-effective platforms, and reduce the mainframes to data base servers and network controllers. It is assumed that this will contain the traditional mainframe growth pattern and eventually reduce the actual investment in mainframe technology.

EXHIBIT IV-3

Case Study #2
Downsizing Cost Factors
Client/Server versus Mainframe

Cost Factors	Data Center	Network Services	Application Custodian	End User
<i>Application Support</i>				
Development	Null	Null	Minus (1)	Null
Maintenance	Null	Null	Minus (2)	Null
Documentation	Null	Null	Null	Null
Training	Null	Null	Null	Null
<i>Hardware</i>				
LANs	Null	Null	Null	Plus (1)
Workstations	Null	Null	Null	Plus (2)
Servers	Minus (1)	Null	Null	Null
Network Backbone	Null	Plus (1)	Null	Null
Environmentals	Null	Null	Null	Null
<i>Systems Support</i>				
Data Quality	Plus (2)	Plus (2)	Plus (3)	Plus (3)
Standards	Null	Null	Null	Null
Systems Software	Minus (3)	Null	Null	Null
<i>Staffing</i>				
Staffing Levels	? (4)	Plus (3)	Minus (4)	? (4)
Local Expertise	Null	Null	Null	Null
<i>Transition Costs</i>	Plus (5)	Plus (4)	Plus (5)	Plus (5)

Key: 1) Plus = Increase in Expenditures
 2) Minus = Decrease
 3) Neutral = Approximately the Same
 4) Null = Unable to Determine from Responses Given

(2) As we have seen, problems of data quality have arisen as the railroad has distributed processing power and data management responsibility to the operating department(s). This has resulted in cycles of centralization and decentralization of data quality responsibility. The problem is that data management becomes increasingly complex in the downsized environment, and it is anticipated that the cost of maintaining data quality will increase at the data center regardless of the advanced technologies (such as image processing) employed.

(3) The cost of systems software has already been identified as a major problem by the data center. However, the insidious (and even sinister) nature of the problem is not always identified. Most mainframe upgrades are required by systems software and not by the demands of customer applications. Basically, the customer pays twice—once in terms of the processing power required to run the systems software and then for the software itself when the mainframe must be upgraded. To the degree that downsizing stops or reverses mainframe growth, systems software expense will decrease accordingly. However, the mainframe systems software trap remains sprung until the mainframes are actually replaced, and IS management has a hard time visualizing how this can be accomplished.

(4) The impact of downsizing on data center staffing is not known, but data quality and systems software support are becoming increasingly complex. Even if UNIX and OS/2 2.0 remain “simpler” than MVS/ESA, the data center will have responsibility for a substantially more complex information technology infrastructure in the foreseeable future. Data center staff will either have to be increased to support this new environment or consultants and/or systems integrators will have to be hired to support end users. (The railroad is talking about doing its own systems software maintenance, but it is probable that management will be looking for reduced data center expenses as downsizing proceeds. IS management is not in an enviable position.)

(5) Transition costs for the data center will be high, with more and “different” hardware/software to install, operate and support. No exact figures (or plan) is currently available, but extracting itself from the current mainframe hardware/software trap will be a “long, painful process.”

b. Network Services

(1) Despite historic investment in a communications technology, downsizing and image processing will require additional investment in the backbone network.

(2) Network management and data base management are becoming practically synonymous in a distributed data base environment, and the railroad's concern about data quality will require network services to provide additional support in terms of general connectivity, and data base synchronization and security.

(3) Network complexity continues to grow, and even organizations that have been traditionally communications oriented will have to either increase network services staff or seek outside help.

(4) Changing the topography of the communications infrastructure is always expensive, and that is precisely what is happening during the transition period.

c. Application Custodian

(1) While the immediate focus at the railroad is on the amount being spent outside the company for systems software, the cost of applications development has been a longstanding concern. The VP of IS, remembering his early days as a programmer, stated that it is "difficult to understand why things take so long." While the investment in COBOL programs is one of the factors inhibiting downsizing, one of the primary objectives of downsizing is to get to platforms that provide tools that are easier to use—thereby decreasing the cost of applications development.

(2) The cost of maintaining those "impossible to maintain" COBOL programs is a major part of the mainframe trap because maintenance of existing applications must take priority over new development work and re-engineering. One of the anticipated benefits of downsizing (and re-engineering) is that the new applications systems will be easier and less costly to maintain. One way of achieving this saving will be to transfer routine maintenance to end users at workstations (presumably even if the workstations aren't hardwired to print out that the IS department is no longer responsible for the content of the report).

(3) When applications are split between clients and servers, problems of maintaining data quality become more complicated. The applications custodian will have to expend considerably more resources assuring that data quality is maintained and improved.

(4) The way application development and maintenance expense can be reduced is by decreasing the size of the programming (and analysis) staff. That is a primary objective of downsizing, and it must be the primary source of cost justification.

(5) However, in the interim, existing applications must be maintained while client/server applications are being developed and/or re-engineered. As it was for the university, the downsizing transition period will be long and expensive.

d. End User

(1) Downsizing applications from minicomputers to client/server LANs, and (at least) some mainframe applications (including transaction processing) to an image processing system(s) is going to result in increased cost for LANs at the end-user level. Image processing (even with compression) takes more bandwidth.

(2) New downsized applications (including image processing) will also require upgrading or replacing currently installed workstations in order to run vendor systems software, and to drive high-resolution displays and their GUIs.

(3) The end-user level is where data and information quality are important, and the railroad is already experiencing quality problems. Quality will be every one's concern as technological downsizing proceeds, and more effort will be expended at all levels in the information systems infrastructure.

(4) Starting 30 years ago, the subject railroad used information technology to downsize staff. Motivated by what it perceived as being featherbedding (such as firemen on diesel locomotives), management took the position that even trivial clerical work should be put on the computer. For example, watch inspection cards for operating personnel were prepared by computer because that was the last remaining function for some clerks. (It may not have been an exciting application, but it permitted management to say "there is no work for this employee" when negotiating with the clerks' union.) In the last ten years the railroad has again made significant staff reductions, while operating personnel have assumed increased responsibilities for information processing activities (including data quality). Truncating paper documents (such as bills of lading) will relieve operating personnel of some paper handling chores, but it appears that the railroad may have started to cut into muscle rather than fat quite some time ago. Therefore, it is questionable whether end-user staffing levels can be reduced without serious impact on customer service.

(5) As new hardware/software systems are installed, users will incur increasing training and overtime costs to become proficient in the new systems. In addition, maintaining quality of both the new and the old systems will be especially burdensome if the transition period in any particular area is prolonged.

In summary, the railroad is currently concerned primarily with improving the quality of customer service. It is caught in an expensive mainframe trap even though it “downsized” to minicomputers nearly 20 years ago. To extricate itself from this trap while improving data quality and customer service will require immediate and dramatic improvement in the performance of the IS department itself (data center and application custodian) because it appears that any required cost justification must come from a reduction in mainframe and applications development costs.

C

Case Study # 3—Proprietary versus Open Systems

Both the university and the railroad find themselves in the mainframe trap—no matter how much they invest in new technologies, the size and expense of mainframes seems to keep going up. It is difficult to see any end in sight, but both are formulating downsizing strategies to alleviate the problems associated with uncontrolled mainframe growth.

Personnel at the university feel that a primary problem is that the university is doing too much of its own mainframe software development (both systems and applications). They anticipate that one of the primary benefits of downsizing will be to enable the university to purchase off-the-shelf software.

The railroad, on the other hand, is saying that the expense of mainframe systems software is a concern of management all the way up to the board of directors. The VP of IS is thinking about getting image processing source code and maintaining some of the packages internally, wishing for a viable alternate to mainframe operating systems, and even thinking wistfully of the “good old days” when he was part of a group that did all of its own systems software development.

The next case study is of a major international energy company that essentially avoided the mainframe trap, but is now doing an assessment of open versus proprietary systems in the downsized environment.

1. Background

The subject company is involved in oil exploration around the world, and in the late 1970s it established a corporate policy of avoiding the use of mainframe computers. This effectively meant that it created a downsized environment by avoiding the “upsizing” inherent in a mainframe-oriented infrastructure. Avoiding mainframes also meant avoiding SNA, and the company installed one of the world’s largest networks of DEC VAX and IBM System/3X (now AS/400) computer systems. It remains on the leading edge of network computing.

Having started early with System/38s, the company is probably the most experienced with using and networking AS/400 architecture computers. That experience can be briefly summarized as follows:

- The System/38-AS/400 architecture provides substantially easier applications development and data base management than does the mainframe environment.
- Early use of the relational model (integrated into the hardware architecture before RDBMSs were commercially available from software vendors) has provided flexibility and an applications set that is easy to maintain.
- Network management facilities have consistently been far ahead of the mainframe environment, and the company is convinced that the AS/400 is the finest distributed data base server on the market today. Advanced Peer-to-Peer Networking (APPN) was available on System/3X computers prior to the announcement of the AS/400, but it is just beginning to appear in the SAA world.
- The company is pleased with the AS/400 hardware/software architecture. It has invested \$15 million in development of network applications based on this technology, and “it works.”
- However, there has been a long and continuing struggle with IBM’s SNA-oriented Communications Division, which for years has stubbornly refused to acknowledge that networking doesn’t require an IBM mainframe. This has led to many exasperated exchanges between communications experts on both sides.
 - There was a running dialogue concerning electronic mail which was like a “soap opera” with IBM repeatedly expressing amazement that a worldwide network of its equipment didn’t have a mainframe to route all messages through. Now when IBM has finally supported electronic mail outside of SNA, its implementation requires both parties to “know” each other in order for one to direct a message to the other. The frustrated AS/400 customer cites this as “another example of mainframe mentality” and the battle continues.
 - Then, when discussing network management philosophy, it always seemed to get back to the old SNA problem of having to take the entire network down in order to add a node.
 - More recently, with the necessity to interface with UNIX-based networks (the company is also heavily into RISC workstations), the question of support for TCP/IP on the AS/400 has led to a continuing controversy and a great deal of contention.

- And, with the recent move of some IBM communications activities to Europe, it seems impossible to find anyone in IBM in the United States who knows anything about Open Systems Interconnection (OSI).
- This all leads to the conclusion that, while IBM potentially has the best distributed data base server in the AS/400, it is not being sold that way, and it is difficult to find anyone in IBM who really understands anything except the traditional SNA approach to networking.
- This type of frustration has finally led someone in network services at the company to state emphatically: "IBM should just get out of the communications business—period."

With that as background, let's take a look at a specific downsizing problem the company is currently facing. How did a company with a policy against mainframes get a downsizing problem, you ask? Very simply; they inherited an IBM 3081 from a business partner in a joint venture.

2. The Downsizing Plan

The energy company is now the less-than-proud owner of an IBM 3081 servicing five remote locations. It was acquired along with a former business partner about 1984; it is fully depreciated (except for a leased 3725 which stands out like a red SNA flag to company communications personnel); the software cost was described as "eating us alive"; and it is in clear violation of the company policy against mainframes.

The IS group responsible for the 3081 was recently reorganized and now reports to corporate headquarters. A simple edict came down: "Get rid of the 3081."

A conversion group was set up. Since the company has approximately 60 AS/400s already installed, it was assumed that the 3081 would be downsized to that platform.

A conversion plan was drawn up. The total cost was approximately \$4 million, broken down as follows: \$2.5 million for the central processing facility, \$.75 million for program conversion, and \$.75 million for the remote data network.

The problem arose when corporate administration questioned the downsizing plan.

3. The Issue—Open versus Proprietary Systems

As mentioned previously, the energy company has an extensive network of both AS/400s and DEC VAXs. At one time, it was one of DEC's largest customers, but over the years first System/38s and now AS/400s

have been gaining percentage of IS budget dollars. Like other minicomputer vendors faced with competition from the AS/400, DEC has belatedly seen the “wisdom” of open systems.

The question from corporate was: Why don't we downsize to DEC systems? They are “open” and there is lots of packaged software available.

The IS department, of course, feels that this question was prompted by the engineering side of the house, which is still using VAXs that have been under increasing pressure not only from AS/400s as data base servers, but from RISC workstations for engineering work. The IS department now finds itself looking at the relative advantages of open systems (UNIX) versus the AS/400 for downsizing the mainframe applications.

Given the extensive network of AS/400s already installed, the possibility of converting completely to open systems may be idle speculation. However, it has caused the IS department to do an analysis of the benefits perceived from the AS/400 architecture versus mainframes, and to assess its long-range direction in terms of open versus proprietary systems.

While this complicates the downsizing cost matrix, it can still serve as a convenient framework for analysis.

4. The Downsizing Cost Model

For this case study, INPUT split the columns of the matrix to reflect the perceived benefits that have been achieved by avoiding the mainframe trap, and also to evaluate the relative costs of the AS/400 as a downsizing platform versus UNIX (open systems). Exhibit IV-4 shows this matrix.

An overview of the matrix reveals that there is general consensus in the IS department that the AS/400 is easier to use (and support) than either mainframes or UNIX-based systems. However, it should be pointed out that there is a substantial base of experience to support this conclusion as far as mainframes are concerned, but the IS department has only limited experience and knowledge with UNIX systems and their supporting software.

EXHIBIT IV-4

Case Study #3
Downsizing Cost Factors
AS/400 versus Mainframe and UNIX

Cost Factors	Data Center		Network Services		Application Custodian		End User	
	Mfr.	UNIX	Mfr.	UNIX	Mfr.	UNIX	Mfr.	UNIX
<i>Application Support</i>								
Development	Null		Null		Minus (1) ?		Null	
Maintenance	Null		Null		Minus (2) ?		Null	
Documentation	Null		Null		Null		Null	
Training	Null		Null		Neut. (3) Minus		Null	
<i>Hardware</i>								
LANs	Null		Null		Null		Plus (1) Neut.	
Workstations	Null		Null		Null		Plus (2) Neut.	
Servers	? (1) Neut.		Null		Null		Null	
Network Backbone	Null		Minus (1) Neut.		Null		Null	
Environmentals	Minus (2) Neut.		Null		Null		Null	
<i>Systems Support</i>								
Data Quality	Minus (3) Minus		Plus (2) Minus		Plus (4) Minus		Plus (3) Neut.	
Standards	Minus (4) Minus		Plus (3) Minus		Minus (5) Minus		Null	
Systems Software	Minus (5) Minus		Minus (4) Minus		Null		Null	
<i>Staffing</i>								
Staffing Levels	Minus (6) Minus		? (5) ?		Minus (6) Minus		? (4) Minus	
Local Expertise	Minus (7) Minus		Minus (6) Minus		Null		? (4) Minus	
<i>Transition Costs</i>	Plus (8) Minus		Plus (7) Minus		Plus (7) Minus		Plus (6) Minus	

Key: 1) Plus = Increase in Expenditures
 2) Minus = Decrease
 3) Neut.ral = Approximately the Same
 4) Null = Unable to Determine from Responses Given

Let's briefly examine the cells that have been rated.

a. Data Center

1) Since the 3081 is fully depreciated, any investment in new hardware should be rated a plus; but, since we are unsure when replacement or upgrading would be required, we have left the question open. We assume that the cost of AS/400 and UNIX-based downsized platforms would be roughly equivalent (including the costs of systems software).

2) Environmental costs for the AS/400 would be less than for the 3081, and equivalent to those for other downsized platforms.

3-5) Systems support for AS/400s (in terms of data base administration, standards, and systems programmers) has been reported to be approximately one-fifth the cost of that for IBM mainframes. [24] This ratio has been confirmed by the subject company in actual practice. Though the ratio would probably not be as high for UNIX-based systems, the integrated architecture of the AS/400 is clearly easier to support than UNIX-based systems since the very "openness" leads to numerous versions and data base choices.

6,7) The lower systems support requirements for the AS/400 result in reduced staffing in the data center, and the ease of use of the AS/400 reduces the data center cost of providing local expertise in remote locations.

8) Conversion is always costly, but it is felt that it will be less costly going to the AS/400 than to other downsizing platforms. (This is especially true in the case of the subject company because of current AS/400 expertise.)

b. Network Services

1) The leased IBM 3725 is visible evidence of the cost of SNA networks, according to those involved with network services at the subject company. The impact on the backbone network is rated a standoff between AS/400 and UNIX-based systems (but communications personnel rate the AS/400 as the best distributed data base server available).

2-4) INPUT is not sure that communications personnel interviewed would agree with its eventual rating of these particular cells. However, there isn't any question that those personnel are becoming increasingly involved in what previously was the province of data base administrators and systems programming personnel. As

soon as data bases are distributed from mainframes out to the network (and especially in a client/server architecture), the distinction between data base management and network management becomes blurred. [24] One person interviewed put it this way:

- “It is fine to talk about scalability and merely having to add another \$20,000 workstation or data server (the low-end models of the AS/400 are down to this level), but the thought that you can do away with systems programmers doesn’t fly. The open environment increases complexity dramatically. Somebody has to put it all together and make it work, and that is where we (data communications personnel) are expected to provide “connectivity” and we just aren’t staffed to do it.”

Going from a highly centralized mainframe environment increases problems of data base management and frequently transfers both data base administration and systems programming functions from the data center to network services. This is especially true with UNIX-based systems that are “communications-oriented,” but have only relatively primitive network management and file transfer capabilities.

Therefore, when moving from the SNA environment on the IBM 3081, network services will incur additional responsibility for data quality (in terms of synchronization, responsiveness and security), and for supporting additional “standards” in addition to (or in lieu of) SNA. (OSI is but one example.) However, when viewed from the point of view of network management software, the AS/400 has consistently been ahead of mainframes; and OS/400 has superior transaction processing facilities compared to large-scale UNIX-based servers, which normally don’t have transaction monitors. Hence the ratings.

- 7) Transition costs for network services (which are essentially the cost of integration into the existing network) would be less for an AS/400 than with a large UNIX-based server.

c. Application Custodian

1-2) The cost of application development and maintenance has been clearly demonstrated to be less on the AS/400 than on IBM mainframes. It was stated that IS personnel who came from the IBM mainframe environment (as many of them did) have said that they will never go back to that development environment. However, one systems person interviewed observed that some people seemed to have forgotten just how bad things were in the mainframe environment—they had become spoiled by working for so many years with the System/38-AS/400 architecture.

This brings up the question of whether UNIX platforms currently have an applications development environment, or packaged software, that is comparable (or superior) to the AS/400. This is a key question the company is currently trying to answer, and it is a key issue for anyone planning a major downsizing project from a mainframe. INPUT will analyze this issue later, after making the following observations:

- The AS/400 currently has more industrial-strength business applications available than any UNIX-based platform, including an increasing number with a “money back guarantee.”
- Some reject the AS/400 as a “development platform” because it does not have highly visible CASE tools, and has only recently acquired a C compiler (although C has always been committed as an SAA language). It should be understood that tens of thousands of small companies, and many multibillion-dollar enterprises (such as the subject company), have developed all of their necessary business applications using RPG (with an occasional smattering of COBOL). There should be a message here.
- OS/400, unlike UNIX, does not require enhancement with DBMSs, transaction monitors, and security packages. And it doesn’t require a lot of additional applications development tools to be a development platform for business applications.

3) Less training should be required for applications developers and maintainers because of the integrated, and easy to use, tool set available on the AS/400. This is true for both the mainframe environment and alternative UNIX-based platforms where training in C for either RPG or COBOL programmers will be a considerable expense. (Remember the AS/400 is being evaluated against UNIX-based systems, and the minus reflects the fact that training expense would be less. There would be a plus, indicating increased cost, in this cell for UNIX if it were being evaluated as the downsizing platform.)

4) Once we get away from those old mainframes and dumb terminals, the application developer and maintainer must be more concerned with data quality. How will data be distributed between client and server? How will these files and/or data bases be synchronized? How will privacy and security be maintained?. These problems are substantially easier to solve on the AS/400 than they are on UNIX-based platforms.

5) Standards concerns for the applications developer are less on the AS/400 because there aren’t as many alternatives available. There is not the bewildering array of operating systems, DBMSs and tools available that there is on either mainframes or UNIX-based systems—

thus simplifying selection, promulgation, and adherence to standards, and avoiding the related political battles. (Enforcing standards on programmers is one of the most thankless and time-consuming jobs imaginable.)

6) Staffing levels for the applications custodian should be lower for the AS/400 than for either the mainframe or open system environment, for all of the reasons mentioned above.

7) The transition costs for converting current mainframe applications to AS/400 have been estimated to be \$750,000, a non-trivial expense, but estimated to be lower than converting to a UNIX-based environment.

d. End User

1-2) The cost of the "remote data network" to support downsizing the 3081 to an AS/400 environment has also been estimated at \$750,000. This cost would include LANs and workstations, and it is assumed that the cost would be approximately the same for UNIX-based systems. (As an aside, IBM has pointed out to its AS/400 customers that they can save considerable money by installing diskless workstations, but the subject company observed that: "nobody wants diskless workstations." The vendor's host mentality dies slowly as the world goes client/server.)

3) Given workstations with disk storage, and client/server architecture, the user must accept more responsibility for data quality and security than in an SNA environment. This results in additional expense regardless of whether it can be quantified. INPUT estimates that this data quality expense at the end-user level will be approximately the same in either the AS/400 or UNIX environments.

4-5) End-user staffing levels and the need for local expertise will depend upon the specific applications that are being downsized, and the nature of the conversion. Straight conversion (as opposed to re-engineering) would probably have little impact when going from a mainframe to an AS/400 environment, but one would hope that if applications were re-engineered, end-user staffing levels would go down. However, generally speaking, the AS/400 requires less technical knowledge and support than do UNIX-based systems, and should be less costly in terms of end-user staffing and expertise.

6) Transition costs for end users may be the Achilles heel of mainframe downsizing efforts because of problems associated with running parallel systems. However, the transition from mainframe to AS/400 is not anticipated to be nearly as traumatic as from mainframe to UNIX-based systems.

The evaluation of an AS/400 downsizing effort versus on “open systems” approach employing DEC equipment and UNIX has been complicated considerably by a recently reported strategic shift by the Open Software Foundation (OSF). [25] Essentially, the OSF is:

- Shifting emphasis from OSF/1 operating system development to concentrate on building “distributed computing and management software”
- This leaves DEC in something of a bind because it had stopped making improvements to its Ultrix system in favor of moving rapidly from Ultrix to DEC/OSF/1. Now it must reallocate resources back to Ultrix. (Oh, the joys of software and standards development by C++++ — consortium, committee, cooperative, college campus, competitors or consultants!)
- The new emphasis of OSF is directed toward the strength of the AS/400, and it is more than a decade behind other developers.

The personal impression of one of the company leaders in evaluating the AS/400 and open systems strategies for downsizing is that any decision to move aggressively toward open systems would be “disastrous” for the company. But the jury is still out at this point.

D

Case Study #4—Downsizing and the Fight for Survival

This case study involves a major minicomputer company that has itself been adversely impacted by PC LANs and RISC workstations. Since the early 1980s, it has reduced staffing levels by nearly 60% as it restructured to meet the challenge of faster product cycles and lower margins. The only way to retain its customer base and stay alive was to adopt RISC technology and UNIX in lieu of its proprietary systems.

The VP of IS believes that the company could not have survived without drastic changes in its internal information systems infrastructure. He also believes that both technological and management downsizing will be necessary for survival by all industries competing in global markets. He has considerable credibility because of his background.

1. Background

The background of the company is similar to that of many minicomputer companies. It has been technology driven rather than market driven for most of its corporate life. Then, as it was beginning to adjust to the challenges of the commercial market, it found itself confronted with the microprocessor and architectural revolutions of the 1980s. Now, it is struggling to survive without the economy of scale of some of its larger competitors.

The background of the VP of IS is not similar to that of most CIOs. His company was chosen as a case study because he has first-hand knowledge of the “upsizing” case study that was presented earlier in this report. He understands the “proper hierarchical model” that was employed: first, centralize and standardize; then provide for the orderly distribution of processing (and data) down to the appropriate level in the hierarchy.

He remembers this model. When asked about the current theory that information architectures can be developed from the bottom up, his only statement was: “You remember Citibank in the 1970s when it let things get out of control.” (This was a reference to the Citibank experience with distributed processing that led to the establishment of little “data fiefdoms” and resulted in internal warfare.)

And, he is no stranger to the client/server model that was employed early in the 1970s in retail point-of-sale and wholesale distribution systems. He held positions heading up a computer services company that employed one of the first such hierarchical networks, and also was head of field service for an organization that was (at that time) the largest supplier of point-of-sale systems. He has a business and customer service orientation combined with pioneering networking experience. This is a difficult combination to find in today’s topsy-turvy IS world.

He has been with the minicomputer vendor for approximately five years, and he directed his attention first to building a network architecture.

2. The Current Network Architecture

The current network architecture is described as “one big LAN.” It has a multiple T1 backbone, and digital fiber optic LANs interconnected by routers. There are three field data centers, and 6,000 devices connected to the network. The concept is the familiar one of providing ready access to “any data base anywhere.” Now the network has been built, and attention is being directed toward applications. (It was considered important to establish the general network architecture before addressing specific applications—undoubtedly because of the conviction that top-down design is necessary if the integration problems inherent in bottom-up development are to be avoided.)

Most applications are home-grown and remain on proprietary mainframe (Amdahl 5800s) and minicomputer systems (the company’s own), and some of them are about 15 years old. The company is currently looking at all applications and data to determine:

- Where data are actually needed and manipulated
- Where data should, and can be, moved (distributed)

- Which are the most cost-effective platforms for data residence and processing
- Where end-user productivity can be improved
- How productivity in the systems development process can be improved through the use of packaged software

It has already been concluded that the strategic direction will be toward downsizing and open systems. This judgment was not based solely on the fact that the company had already reached the same business decision concerning its product line, but rather upon the expense and inflexibility of current information systems. As mentioned previously, the company does not believe that its internal IS problems are any different from those of other companies; and, therefore, feels confident that both its business and information systems strategies are on the right track.

3. Downsizing, Open Systems and Survival

a. Factors Prompting Downsizing and Open Systems

Current applications systems are not responsive to either changing business needs or a changing technological environment. They are “frozen in time” on expensive hardware/software platforms and absorb a high percentage of IS resources just to maintain. They represent “competitive disadvantage” when competitors are able to implement (or re-engineer) more flexible and responsive systems on more cost-effective platforms. Simple survival becomes the primary factor prompting downsizing when these new systems result in improved productivity and customer service.

b. Factors Inhibiting Downsizing

Many existing applications, and their supporting data bases, were originally designed as separate systems. There is a need for applications integration and a data base architecture before deciding what should, and can, be moved where. Otherwise, the arbitrary distribution of data to surrounding platforms on the “one big LAN” will only compound an already difficult data base management problem. It is estimated that it will be two or three years before substantial progress can be made in distributing mainframe data bases. (We assume that there was never an effective centralization and standardization phase while the company’s network of mainframes and minis was evolving, and that the VP of IS is now developing a data base architecture for purposes of centralized management and control.)

c. Application Selection for Downsizing

Although mainframe data bases pose a formidable obstacle to rapid implementation of the downsizing strategy, the VP of IS states that there are things that “can be done today.” In addition to the usual ad hoc reporting that practically everyone agrees can be downsized to more cost-effective platforms, he emphasizes the fact that a considerable amount of current mainframe transaction processing can be offloaded (downsized) as well. The company is currently working with a major software firm on the development of intelligent data streams that will reallocate work between clients and servers so that processing is done on the most cost-effective platform.

As mentioned earlier, a top-down review of applications and data is being made to design an information architecture, but applications are selected for downsizing and re-engineering based on business objectives. For example:

- It was determined that customers were having to call two organizations in order to straighten out billing problems—one for regular bills and one for customer service. The two billing systems were separate, and nothing alienates customers faster than billing problems. Since a major business objective was to retain the customer base, this surfaced as a major problem.
- The whole operation was put under one management, and the two systems were integrated and re-engineered as an image processing system using the company’s new, open (UNIX-based) product line.
- The new applications system saved:
 - \$50,000 in processing costs
 - \$26,000 in overtime personnel costs
 - \$3,000-4,000 in paper costs
 - And, most important, improved service to the customer

4. The Downsizing Cost Model

IS management has assumed an important, and central, role in the survival strategy of the subject minicomputer vendor. Specifically, the VP of IS has assumed a position of leadership in facilitating management strategies designed to make the company more competitive in the most beleaguered product area in the information technology industry. It is obvious that information technology must play an increasingly important role in a company that is making such drastic personnel reductions while attempting to maintain its customer base.

Therefore, unlike other companies, the role of the CIO (centralized control of information resources) is actually being enhanced in this company. Attesting to this fact, the VP of IS acquired administrative control of European information systems activities during the course of the research for this study.

The fact that the information systems infrastructure is described as one big LAN is significant when one looks at the anticipated cost impacts of technological downsizing. It seems obvious that this highly centralized view of the network architecture that has currently been implemented is based on the management centralization of computing resources regardless of where they are located. The network is viewed as just a means of "wiring together" all of the computers so they can be more effectively managed.

For that reason, unlike the preceding case studies, network services will be integrated with the data center in the cost model shown in Exhibit IV-5.

a. Data Center

Downsizing is the aftermath of the personal computer revolution. The data center is expected to provide quality data so end users can control their own destinies. The IS department has been relegated to the role of data custodian. So the story goes.

This case study does not fit the story line. The data center has extended its power through the development of an all-encompassing network architecture. Downsizing is viewed as the "orderly distribution of processing and data" to appropriate levels in the processing (and organizational) hierarchy. Depending upon one's point of view, this may be viewed as the triumph of professionalism over the rabble or the ruthless suppression of the legitimate aspirations of end users for empowerment.

However, there is no question about who is in control here, and this is reflected in the general cost analysis.

1-2) Since the data center is responsible for the orderly distribution of processing and data to end users, it will have increased responsibility (and cost) for documentation and training as downsizing proceeds.

3-5) A considerable investment has been made in the "one big LAN," and increased investment will be necessary as downsizing proceeds. It is anticipated that the increased cost of LANs and network backbone will be more than offset by savings in "servers" (mainframes) as downsizing proceeds. The statement was made that there are potentially "tremendous savings" on hardware since RISC-based minicomputers will cost only a quarter as much as current mainframes.

EXHIBIT V-5

Case Study #4
Downsizing Cost Factors
Client/Server versus Current

Cost Factors	Data Center	Network Services	Application Custodian	End User
<i>Application Support</i>				
Development	Null	Null	Minus (1)	Plus (1)
Maintenance	Null	Null	Minus (2)	Plus (2)
Documentation	Plus (1)	Null	Plus (3)	Null
Training	Plus (2)	Null	Null	Null
<i>Hardware</i>				
LANs	Plus (3)	Null	Null	Null
Workstations	Null	Null	Null	Plus (3)
Servers	Minus (4)	Null	Null	Null
Network Backbone	Plus (5)	Null	Null	Null
Environmentals	Null	Null	Null	Null
<i>Systems Support</i>				
Data Quality	Plus (6)	Null	Plus (4)	Plus (4)
Standards	Plus (7)	Null	Plus (5)	Null
Systems Software	Minus (8)	Null	Null	Null
<i>Staffing</i>				
Staffing Levels	Plus (9)	Null	Minus (6)	Minus (5)
Local Expertise	Plus (10)	Null	Null	Null
<i>Transition Costs</i>	Plus (11)	Null	Plus (7)	Plus (6)

Key: 1) Plus = Increase in Expenditures
 2) Minus = Decrease
 3) Neutral = Approximately the Same
 4) Null = Unable to Determine from Responses Given

6-7) The data center has retained responsibility for data quality during downsizing. Distributed data base management (and administration) will require more effort as downsizing proceeds. In order to minimize complexity (and avoid chaos), it can be anticipated that additional standards for client hardware and software will have to be established and maintained. (While some standards problems have been simplified by the company adopting an open systems strategy for its product line, there remain many open issues in the software area—especially in the applications enabling area.)

8) One of the primary incentives to downsize and get rid of mainframes is the burden of systems software on both performance and the IS budget. (Downsizing will eventually drive down the cost of mainframe systems software even if mainframes aren't replaced—competition can work wonders.)

9) The responsibility for managing “one big LAN” and the increasing importance of IS in supporting organizational downsizing will insure that staffing levels for the information systems infrastructure (the data center, including network services) will increase. Some of this increase may be hidden by normal (and creative) accounting, but the number of people literally working for the data center is going to increase.

10) The data center will also be responsible for providing local expertise in the application and use of information technology resources. This will require increased staffing even if end users pay, either directly or indirectly, for these services.

11) The fact that it will take two or three years to make significant progress toward eliminating mainframes indicates that there will be significant transition costs. Hopefully, the awareness that downsizing will require considerable effort will permit transition costs to be minimized. Unreasonable expectations, especially in terms of immediately reduced mainframe costs, can be extremely expensive when they are not met.

b. Application Custodian

1-2) The VP of IS remembers when he worked closely with IBM in developing an early bill of materials processor, which later became an IBM product. He is firmly of the opinion that packaged software will play an increasingly important role in the downsized, open environment. Reducing the cost of applications development and maintenance is a primary source of cost justification for moving to that environment. This company has bet its future that these cost savings will materialize—not only internally, but in the marketplace. However, being the pragmatist he is, the VP of IS readily states the following:

- The key to success in any systems project, whether building a network or developing a complex application system, is “good people”—preferably a few good people.

- Another important factor is attacking the project head on rather than considering all of the alternative implementation strategies. (In other words, actually doing it rather than talking about it.)
- Last, but not least, he recommends “measuring twice and cutting once”—in other words take care to know exactly what you want to do and do it right the first time; it is usually extremely expensive to correct analysis problems later in the systems development process.

3) The increased documentation costs will occur because standalone systems are being re-engineered and integrated as they are being downsized. As data base management becomes more complex, more documentation is required on the part of the applications custodian to assure proper use of data and to insure against data base contamination.

4-5) The applications custodian becomes the vital link between client and server in terms of data quality and the standards necessary to maintain quality. It is the cooperative application that bridges these two domains, and it is a codependent relationship. This is especially true because the case study company is planning to move some transaction processing to minicomputers and workstations before mainframe data bases can be fully distributed.

6) Despite the increase in data base management responsibilities, it is anticipated that reduced application development and maintenance costs will permit a net reduction in staffing.

7) An important point was made about transition costs—why should the company be so worried about transition costs when many of them are really maintenance costs? The fact that there is a new term (downsizing), and a stated goal (offloading of mainframes) should not obscure the fact that a great many applications have been re-engineered and/or shifted to more cost-effective platforms under the guise of maintenance for years. Some provision should be made for writing off transition costs as maintenance or vice versa (whatever makes management happy). (The next case study will demonstrate that this particular IS VP is not the only one to view cost in this manner.)

c. End User

Drastic downsizing of personnel has already taken place in the company. Information technology is being substituted for these human activities. That means that the remaining employees, at all levels, will be spending more time dealing with artificial systems at the human/machine dyad.

1-2) By INPUT's definition, someone using a spreadsheet package or a report writer is developing and/or maintaining an application. [2] The case study company acknowledges that employees, of necessity, must spend more time sitting at their workstations and using these (or other) tools.

- 3) The client/server environment will require more investment in workstations to run advanced operating systems, applications enabling tools, and applications. Access to data anywhere on this "one big LAN" implies a level of systems software sophistication that will assure upgrading of practically all existing personal computers. (Standards set will be for minimum configurations, but some provision will probably have to be made to control these costs—whether by the data center or by the end-user departments.)
- 4) Personal data bases, if they are shared, will require a different level of quality control than standalone PC users have normally exercised—regardless of whether these standards are established by the data center or applications custodians.
- 5) Regardless of how severe the cuts have been to date, the ultimate objective of downsizing is to provide better information technology tools so fewer employees can do more (and perhaps superior) work in less time at the end-user level.
- 6) Transition costs will exist at the end-user level even as staffing levels decrease. Until information technology catches up with staff reductions, these costs can manifest themselves in overtime charges. (The billing systems cited previously are a good example; the downsized system reportedly "saved" 2,600 hours of overtime.)

This has been a case in which downsizing is literally a question of survival. The fact that internal information systems are being emphasized as a means of achieving management objectives during this difficult period indicates that management has the courage of its convictions concerning both its business plan and the current course of information technology toward downsizing and open systems.

All of the preceding case studies have involved large organizations.

Several fundamental conclusions about the trend to downsizing can be reached from the preceding case studies:

- Mainframe hardware/software is viewed as being complex, difficult to use, and expensive.
- IS management's traditional reliance on mainframe solutions is becoming increasingly difficult to rationalize against the potential price/performance advantages of alternative platforms.
- There is considerable desire and motivation on the part of management to be freed from what is viewed as being an oppressive, and even exploitative, information systems infrastructure that is not responsive to business needs.

- Devising an effective strategy for eliminating the mainframe burden (or escaping from the mainframe trap) seems to be extremely complex, technically and politically.

The next case study records the experience of one of the few companies that has actually replaced all of its mainframe computers under the downsizing “umbrella.”

E

Case Study #5—Actual Transition to a Downsized Environment

This case study of a medium-sized consumer products company owned by a major international conglomerate has been publicized in vendor and professional publications, and in the trade press, as an example of the advantages of downsizing from an IBM mainframe to an open systems (UNIX) environment. The case turns out to be substantially more complex than would appear on the surface; but, while INPUT’s analysis raises some additional questions, it does clarify some of the major issues and cost assumptions.

1. Background

The subject company had already started a major applications review when the international conglomerate took over in late 1987. At that time, there were two Unisys (an A12 and an A09) and one IBM mainframe (3090, 120E) installed. Some of the applications on the Unisys systems were quite old and the thought was to upgrade the 3090 (at a cost of approximately \$1 million) and convert at least some of the Unisys applications to that system.

a. Factors Prompting Downsizing

The new VP of IS had installed several Pyramid systems elsewhere in the conglomerate and was convinced of the advantages of open systems and the cost benefits that could be derived from downsizing. He could sense the proprietary mainframe trap, and he had the practical experience to know there was a workable alternative. A command decision was made to eliminate the 3090 as soon as possible and avoid the hardware/software cost escalation inherent in starting at the low end of the IBM mainframe line. The Unisys mainframe applications would be downsized later.

b. Factors Inhibiting Downsizing

The company had a traditional COBOL-oriented shop unfamiliar with either the tools or concepts of open systems and downsizing; in addition, it was located in a small town where the supply of skilled systems personnel was extremely limited.

In addition, the company was losing money and the parent conglomerate would soon be forced to seek bankruptcy protection.

Fortunately, the VP of IS's combination of decisiveness and actual experience with Pyramid systems resulted in successfully forestalling what could have been a traditional spiral of increasing information technology costs. This is not to say that transition was easy.

2. Transition to Downsizing

a. Important Decisions

As INPUT has played various companies' downsizing plans (or thinking) against the cost model, the importance of transition costs has become apparent. A major transition cost that is frequently overlooked is deciding what is "feasible" and then selecting among various alternatives. It is possible to spend an enormous amount of time and money deciding what to do without achieving any benefits whatsoever. For example, the university narrowly avoided spending \$500,000 for "advice and counsel" on an information architecture that would have resulted in limited tangible benefits in actually moving toward that architecture. It is possible to incur substantial "transition costs" while standing still or retrogressing.

The subject company avoided these unnecessary, up-front transition costs; and by prompt action stopped an in-process "upsizing" that would have made any later downsizing effort all the more difficult. The importance of this decisive action cannot be overemphasized.

Two other important decisions were made early on:

- It was decided that large systems integrators would not be employed to assist with the downsizing effort because: "We were in a hurry. We couldn't afford to sit down with a large integrator and write contracts dotting every 'i' and crossing every 't'." (It was recently reported that, as an alternative, a small systems integrator specializing in "mainframe knockoffs for UNIX and UNIX clones" was employed and "turned around the job (of replacing the 3090) in 12 months at a cost of approximately \$250,000." [26] This turns out to be somewhat misleading, and it will be discussed later.)
- It was also decided that 3090 applications would not be re-engineered, but rather converted as rapidly as possible to the Pyramid system. This enabled the 3090 to be replaced in 1989—a year after the decision was made. If applications had been re-engineered, the conversion "would still be going on." This requires some explanation.

b. Re-engineering During Downsizing

The IBM mainframe was being used primarily for decision support for sales and marketing, and the Unisys systems were used for operational applications (such as manufacturing). The thinking had originally been that the operational systems would be moved to the upgraded IBM 3090 and more closely integrated with the decision support systems. The decision not to re-engineer when downsizing was specifically directed toward shortening the transition period (for downsizing the 3090 applications) and achieving major cost benefits as soon as possible. This resulted in the following:

- The 3090 applications (stated to be “approximately 2,000 procedures and programs”) were rapidly converted using Oracle on the Pyramid systems. However, this rapid conversion was possible because most transaction processing (updates) remained on the Unisys systems.
- Some of the Unisys operational systems were old COBOL programs that were unstructured and extremely difficult to maintain. There was never any question that they would have to be re-engineered. These applications have been downsized primarily using Oracle and Pyramid systems and Unisys 6000s (under SCO UNIX).
- However, it has been found that the re-engineering of these applications systems require programming in C+, and the last of the Unisys mainframes is just being replaced—nearly three years after the 3090 was rolled out the door. (This would seem to substantiate the fact that the 3090 downsizing effort “would still be going on” if it had been decided to re-engineer and integrate those applications while downsizing.)

Some good business and technical decisions were made during the course of this downsizing effort, and it was a significant achievement. The results when viewed against the cost model are both impressive and informative.

3. The Cost Model

One thing that must be taken into consideration in viewing the impact of downsizing on costs is the fact that the company’s business took a nose-dive during this period. Production (and presumably revenue) dropped approximately 30%, and the parent conglomerate was operating under bankruptcy protection. It is difficult to assess how important this business downsizing was in prompting and accounting for the impact of information technology downsizing, but the generally depressed environment should be borne in mind. The downsizing cost factor matrix for this case study company is shown in Exhibit IV-6.

EXHIBIT IV-6

Case Study #5
Downsizing Cost Factors
Client/Server versus Mainframe

Cost Factors	Data Center	Network Services	Application Custodian	End User
<i>Application Support</i>				
Development	Null	Null	? (1)	Null
Maintenance	Null	Null	? (2)	Null
Documentation	Null	Null	Null	Null
Training	Plus (1)	Null	? (3)	Null
<i>Hardware</i>				
LANs	Null	Null	Null	Null
Workstations	Null	Null	Null	Minus (1)
Servers	Minus (2)	Null	Null	Null
Network Backbone	Null	Null	Null	Null
Environmentals	Minus (3)	Null	Null	Null
<i>Systems Support</i>				
Data Quality	Null	Null	? (4)	Plus (2)
Standards	Null	Null	Null	Null
Systems Software	Minus (4)	Null	Null	Null
<i>Staffing</i>				
Staffing Levels	Minus-Plus (5)	Null	Minus-Plus (5)	Minus (3)
Local Expertise	Plus (6)	Null	Plus (6)	Null
<i>Transition Costs</i>	Plus (7)	Plus (1)	Plus (7)	Plus (4)

Key: 1) Plus = Increase in Expenditures
 2) Minus = Decrease
 3) Neutral = Approximately the Same
 4) Null = Unable to Determine from Responses Given

a. Data Center

1) While up-front costs associated with the downsizing effort were kept to a minimum by the decisive actions taken in deciding to go to the Pyramid-Oracle open systems environment, the initial training costs associated with downsizing cannot be minimized. It was reported that the company invested nearly 900 man-days in training for various development and technical staff in order to get the downsizing effort under way. Since the total IS staff was 94 people (and shrinking) this represents approximately 10 days of training per employee—a significant initial investment under any circumstances.

2-4) However, such training costs can be easily justified when mainframes can actually be replaced.

- It was estimated that over \$500,000 a year was saved on software license and maintenance fees on the 3090 alone.
- In addition, lower operating costs in the form of depreciation of equipment, cooling, power, etc. were stated to be “substantially more than one-half million dollars” when the 3090 was replaced.
- For the last half of 1992, the base operating budget will be running at an annual rate of \$1.2 million per year, down from \$3.9 million before the downsizing effort started!
- It is also reported that the Pyramid system(s) provide improved response time and have more capacity than the replaced mainframes. In addition, there is improved scalability for containing costs of new applications.

Even allowing for decreased business volumes, bankruptcy protection, and creative accounting, one has to be impressed with these results.

5) Overall IS staffing levels (including systems development) had been reduced from the original 94 to 68 when research for this report was completed. This is a reduction of approximately 30% and corresponds closely with the previously cited 30% reduction in business volumes. However, salary costs over the same period have actually increased from \$2.7 million (1988-89) to a current level of approximately \$3.0 million per year. For the data center, this can be explained as followed:

- It is difficult to find UNIX systems programmers and/or systems administrators, and a premium price must be paid for them.
- Once personnel have been trained in UNIX, they become more valuable; and with the trend toward downsizing, they have considerable mobility. Therefore, salaries tend to increase rapidly. (Actually, the subject company is located in a relatively small town, and this problem shouldn't be as bad there as it would be elsewhere.)

- Therefore, it is not entirely unreasonable that salaries have increased by approximately 30% over the last four years as headcount has decreased.

6) When moving to a UNIX client/server environment from what was essentially a dumb terminal environment, it is necessary for the data center to provide local expertise and support for the LANs. Once again, this is an additional expense even if data center headcount decreases overall (or how this expense is treated for accounting purposes).

7) Transition costs for the data center were minimized because of the rapid replacement of the 3090, but there was a period when IBM, Pyramid and Unisys systems were all installed. Just as with training costs, some up-front investment is needed during major equipment transitions. Anticipation of these costs was the reason the VP of IS was "in a hurry" to downsize.

b. Network Services

1) Running multiple, incompatible mainframe systems resulted in a networking horror; some employees were operating with an IBM terminal, a Burroughs (Unisys) terminal and a PC on their desks. The network had to be completely redesigned during the transition, and there was naturally some expense connected with this. (The net effect of the redesign has not been estimated, but the desktop real estate has most certainly been reduced.)

c. Application Custodian

1-3) As mentioned previously, we are confronted with the fact that headcount has decreased but the salary budget has increased. Systems personnel familiar with UNIX, Oracle and C are not easy to find, train or retain. The long-term impact on the cost of systems development, maintenance, and training of systems personnel is not known. This is one of the most crucial issues associated with downsizing to an open systems environment, and it will be analyzed in more detail later in this report. However, there are two observations that can be made on the current case:

- INPUT has long believed that productivity in the systems development (or maintenance) process can be improved only by having fewer, more highly skilled systems personnel. Therefore, it is possible that staff reductions and higher salaries may result in lower costs.
- On the other hand, turnover of systems personnel is extremely costly in terms of development, maintenance and training expense. The subject company may be fortunate because job opportunities are restricted due to geographic location; but finding, training and keeping high-quality personnel, during and after downsizing, is going to be a major challenge for most companies.

4) Passing data back and forth among the Unisys and IBM mainframes presented file transfer and data quality problems that should actually be improved by the move to Oracle. However, the re-engineering of the old applications did not make exclusive use of Oracle, and systems integration is still not complete because of the rapid conversion of the 3090 systems. Perhaps increased effort to maintain data quality is just going to be a way of life in tomorrow's downsized world.

5-6) The decreased headcount and increased salary level phenomenon has already been discussed. (See the comments under Data Center, above.)

7) The article concerning the hiring of a small systems integrator that specializes in "mainframe knockoffs for UNIX" and the \$250,000 conversion cost that was cited, prompted INPUT to clarify the situation with the VP of IS at the subject company. It turns out that the systems integration firm provided contract programmers for the conversion effort, but it was planned, managed and implemented primarily with in-house personnel.

The total transition costs for the downsizing of all mainframe applications has been roughly estimated at \$2 million. It was cautioned that this estimate was extremely rough and certain trade-offs (such as the cost of acquiring a manufacturing system for the IBM mainframe if the company had not downsized) are incorporated in estimating the downsizing conversion costs. We understand the complexity of accounting for such costs, and are sympathetic to those who cannot estimate transition costs in advance, but this only emphasizes how critical transition costs are in planning a downsizing effort.

d. End User

1) While it is probable that additional investment has been made in workstations, it has to be less costly than having to put up to three workstations on a single desk to tie into the old mainframe environment. We will give them the benefit of the doubt on this one and say that workstation costs (and the desks to support them) will decrease.

2) The client/server environment places additional responsibility for data quality on end users—where it belongs.

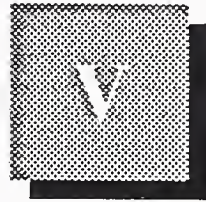
3) The combination of re-engineering and systems integration that is going on should permit end users to be more productive, and it is reported that new applications have already been installed. That end users are more productive is illustrated by the fact that the company was losing money at the higher levels of production, but is now making money at the lower levels. This can only be accomplished by a leaner, more productive work force, supported by improved information systems.

4) This transition could not have been effective without considerable effort on the part of end users. Although this has not been quantified, it is important to recognize that unless end users are actively involved in making the new systems work, downsizing efforts are going to fail. In this case, the effort was successful and the company returned to profitability.

This case study company was selected because it was reported that an IBM 3090 mainframe computer being used for commercial applications had been quickly and cost effectively downsized. Most other reported cases of IBM mainframes being replaced seemed to be either dedicated applications (such as reservation systems) or 4381s. Though this case study has been well publicized as a 3090 replacement in various publications, only once was any mention made of the fact that it was the entry-level model of the 3090, a 120E, that had been replaced.

Having completed these case studies, we find that organizations that have been on the leading edge in applying information technology are having difficulty downsizing their large IBM mainframes—at least, as expeditiously as management feels this should be done. In the cases of the university, railroad, and energy company, published information concerning downsizing and open systems seemed to be influencing (and perhaps confusing) management thinking on the subject.

INPUT decided to extend a content analysis of trade publications begun in the original research for this downsizing program by analyzing *Computerworld* for the first three months of 1992. The purpose of this analysis is to determine the type of information that is being generally disseminated, and how it might be construed by the casual (or even not so casual) reader.



Published Case Studies

The strategic case studies indicate that the groundswell for downsizing is being supported by both the trade press and the popular media. It is important to go beyond the headlines to understand what is really happening. INPUT recognized this when it initiated its downsizing program last year, and did a literature search for case studies that yielded some surprising results.

Since it is now apparent that much of the impetus for downsizing is being generated by published case studies, INPUT decided to supplement this report with a brief review of downsizing efforts that were publicized in the first three months of 1992.

A

The Original Case Studies

As part of the original research for the downsizing program, INPUT conducted a literature search for appropriate cases studies. These case studies were used as examples in *Putting Downsizing in Perspective* [2]. They were used to make the following points in that study:

- Downsizing to PC LANs does not necessarily result in reduced systems staff and may require more highly skilled (and adaptable) personnel.
- Shrink-wrapped software cannot be substituted for commercial applications without considerable systems support and "programming."
- Downsizing from IBM mainframes to RISC/UNIX-based platforms and commercially available DBMSs (in the case cited, Pyramid open systems and an Oracle relational DBMS) can result in substantial cost savings in software licenses and maintenance.
- Replacing a mainframe computer is a long, involved process, and most case studies are published before the mainframe has actually been removed.

1. Downsizing Corporate IS

Let us begin with the downsizing of the Corporate IS function. In an article entitled, "When the CIO becomes expendable" [4], *Computerworld* reported that many organizations were virtually eliminating the corporate IS function, and downgrading the CIO. The following changes in title for the "IS chief" were cited:

- At Rubbermaid, Inc:
 - The former title was Corporate Vice President, MIS
 - The new title is Manager, Analysis Planning
- At United Technologies:
 - The former title was Corporate Vice President, IS
 - The new title is Director, Corporate IS
- At ASEA Brown Boveri:
 - The former title was Vice President, Information Services
 - The new title is Director Computer and Applications Services
- Alco Standard:
 - The former title was Vice President, MIS
 - The new title is Director MIS & Personnel

There is no indication that reducing the size and stature of the corporate IS function was accompanied by reduced IS costs. In fact, there is growing awareness that the preferred architecture for downsizing (client/server) may not cost less, and there was an article in the same issue of *Computerworld* that cautioned readers in this regard. [5]

It seems obvious that corporate downsizing designed to empower autonomous business units can have an adverse impact on corporate IS departments independent of the downsizing of information technology itself.

2. Downsizing Mainframes

The trend toward downsizing and open systems has received a lot of type and hype from the trade press. Headlines abound supporting the delusion that mainframes and proprietary systems are headed for oblivion because they are no longer competitive, and that no one is buying proprietary systems these days. When INPUT decided to look behind the headlines and do a content analysis of these case studies, it managed to pull together the formidable list in Exhibit V-1.

EXHIBIT V-1

Downsizing Case Studies

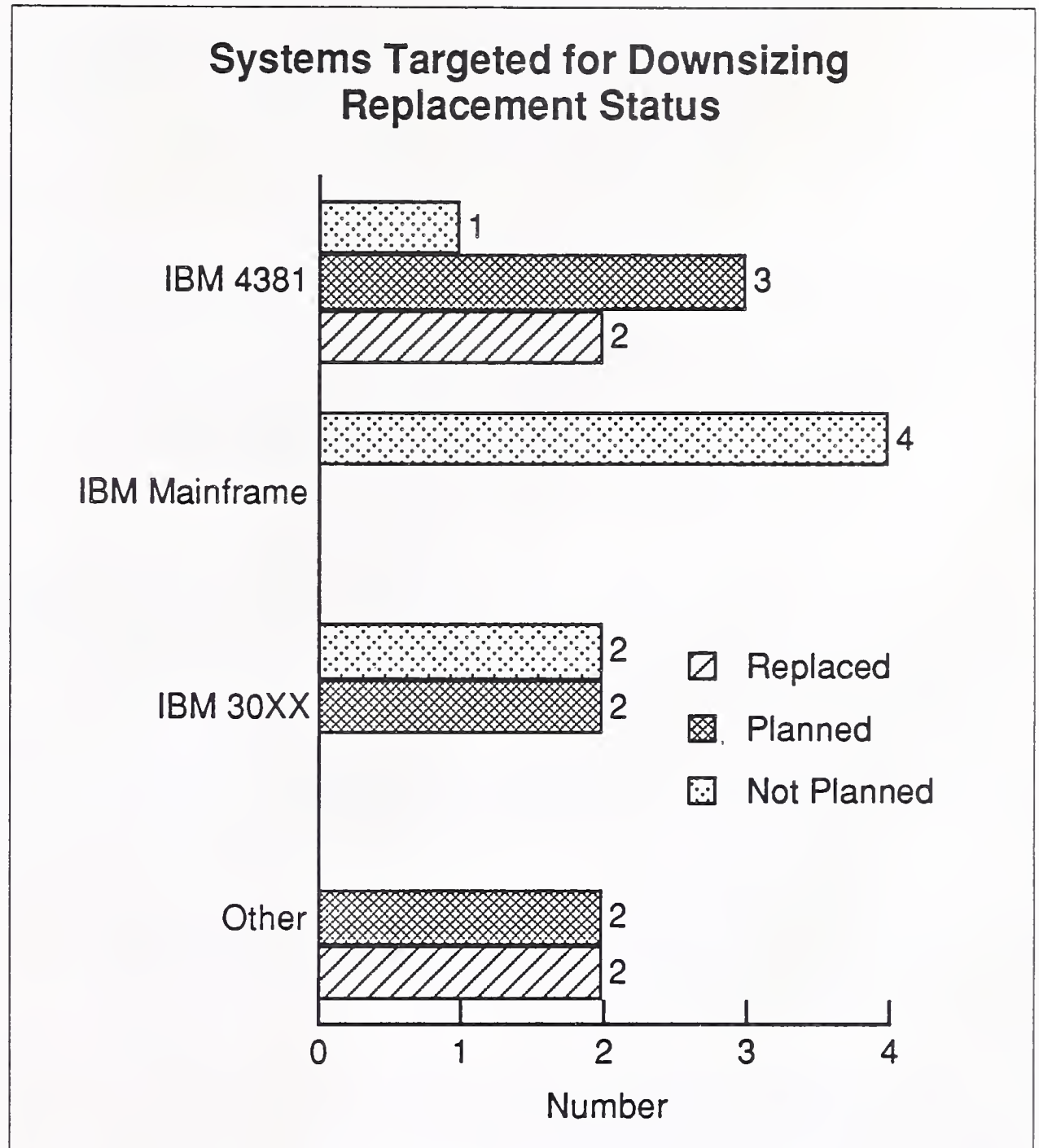
Company	From	To	Replacement	Cost Benefits	Ref.
Northrup King	IBM 4381	AS/400	Completed	"Easier Devel"	[18]
Merrill-Lynch	IBM Mainframes	Sun Client/Server	Never	\$2M --> <\$1M	[19]
Revlon	IBM 3090	HP Client/Server	Planned	Not mentioned	[20]
TRW Corp	IBM 4381	PC Client/Server	1991	-63% IS Staff	[17]
Georgia-Pacific	IBM 4300s	AS/400s	"Recently"	Not mentioned	[17]
Dakin, Inc.	Unisys V Series	AS/400s	1991	-62% IS Staff	[6]
Motorola, Inc.	IBM Mainframes	RISC - MS 8000	Planned	< IS Investment	[7]
Moog Automotive	IBM 3083J	AS/400s, PC LANs	Not planned	Faster Dvlpmnt	[8]
Taylor Medical	IBM System 36s	PC Client/Server	Within 6 months	"Response time"	[9]
GTE TeleOps	IBM & MH Mnfrms.	HP Client/Server	Only Honeywell	Not mentioned	[10]
Batesville Co.	IBM 4381	UNIX-Server	May outsource	-11% IS staff	[11]
GE Capital Corp	IBM 3090	"PC front ends"	No plan	Not mentioned	[11]
Breuners	IBM 4381	HP Client/Server	Planned	-32% IS Staff	[12]
United Airlines	IBM Mainframes	PC Client/Server	No plan	Not mentioned	[13]
Holiday Inn	IBM Mainframes	HP Client/Server?	No plan	Not mentioned	[14]
Haggar Co.	IBM 3090	AS/400s	Within 18 months	Not mentioned	[15]
Orange Cnty FL	IBM 4381	PC LAN	"Within months"	-\$800,000 (44%)	[16]

This sample, taken mostly from *Computerworld* (two of the 17 cases came from *InformationWeek*), reveals the following:

- Fourteen of eighteen systems being targeted for downsizing are IBM mainframe systems. (One of the case study companies had both IBM and Honeywell mainframes installed, so there were 18 targeted systems in the 17 companies.)
- Six of the IBM mainframes were specifically designated as being IBM 4381s, thus confirming INPUT's earlier analysis that 4381s presented an especially attractive target.

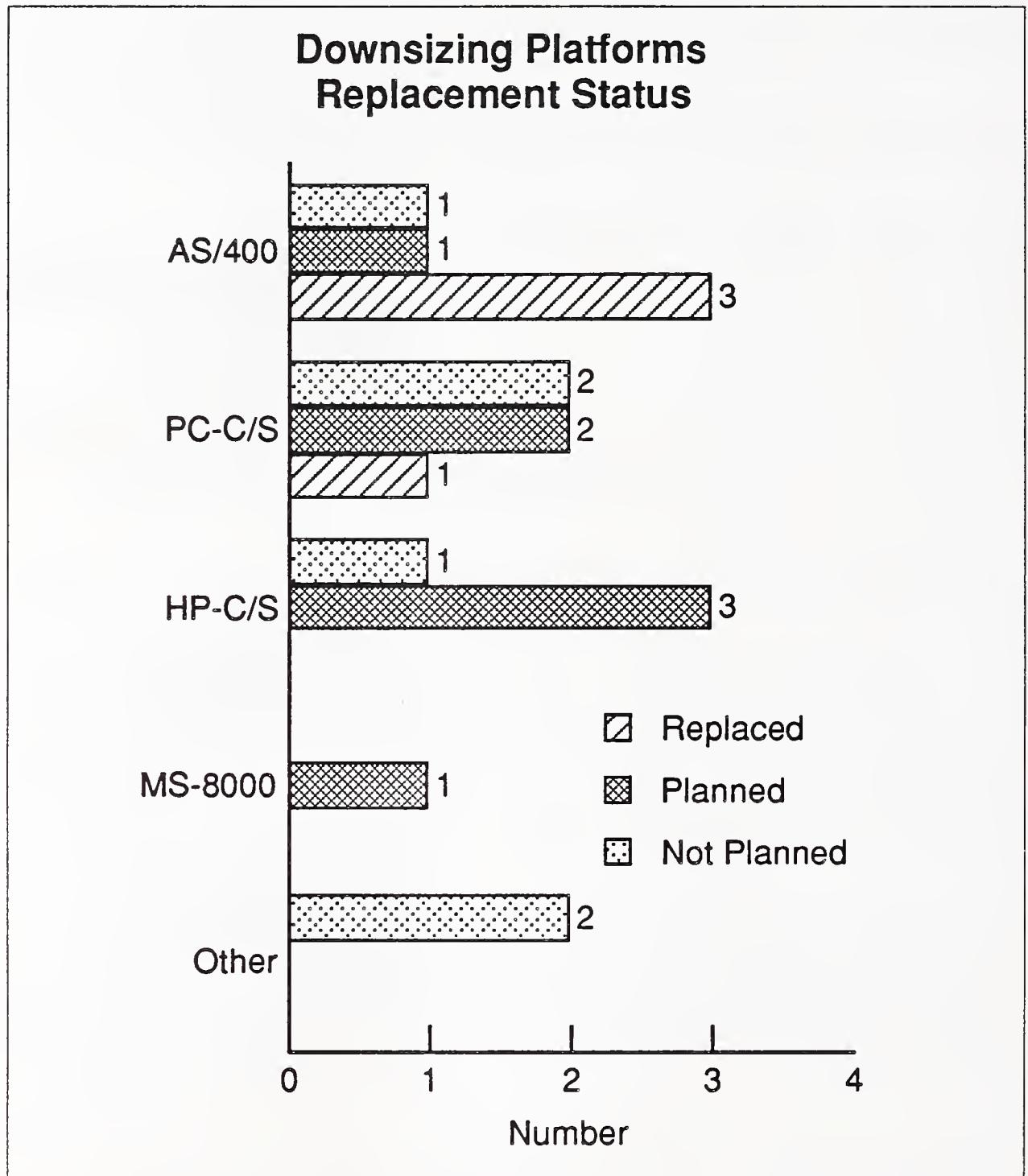
- Four of the IBM mainframes were specifically designated as 30XX systems.
- Four were classified as IBM mainframes without specific designation and could be either 4381s or 3090s.
- The remaining four case study companies had the following systems targeted for downsizing:
 - A Honeywell mainframe
 - Unisys V Series Computers
 - IBM 4300 series (without specific designations)
 - IBM System 36s
- Analyzing these target system categories by their replacement status reveals the following (see Exhibit V-2):
 - Two 4381s have already been replaced, and three are planned for replacement. Only one of the case study companies did not have a replacement plan, and that one said it might have to outsource any remaining 4381 workload. The 4381, positioned at the bottom of the IBM mainframe escalator, is extremely vulnerable from both above and below.
 - The four companies that have multiple IBM mainframes installed (without specific model designation), have no current plans for replacement. It is probable that these companies are planning to control mainframe growth by downsizing specific applications and functions from these installed systems.
 - Two of the four IBM 30XX systems are scheduled for replacement—one within 18 months and the other in 2 years. There are no reported plans to replace the other two.
 - The “other” systems are a curious lot. They include the following:
 - The Unisys V Series equipment at Dakin, Inc. was evidently replaced last year.
 - Some IBM 43XXs at Georgia Pacific were replaced “recently”—and since it was not specifically stated that they were 4381s, INPUT included them in the “other” category.
 - In the GTE installation, which had mixed IBM and Honeywell mainframes, the Honeywells are scheduled for replacement, but it was not specified when this would occur.

EXHIBIT V-2



- Finally, there are some IBM System 36s at Taylor Medical that are scheduled to be replaced (by client/server PC LANs) within the next six months.
- When the platforms being used for downsizing are analyzed based on their success in replacing the targeted systems, we find the following (Exhibit V-3):
 - AS/400s have replaced an IBM 4381, the Unisys V Series equipment, and the Georgia Pacific IBM 43XXs (in other words, in three of the four cases studies where actual replacements have already occurred). AS/400s are scheduled to replace a 3090 within the next 18 months at Haggard Company. However, at Moog Automotive, Inc. it is not anticipated that an aging IBM mainframe will be replaced any time in the foreseeable future, even with a combination of AS/400s and PC LANs.

EXHIBIT V-3



- PC LANs (usually in a client/server architecture) have had the following impacts:
 - They have succeeded in replacing a 4381 at TRW.
 - They are scheduled to replace another 4381 (“within months”) at the Orange County, Florida Appraisers Office, and they are scheduled to replace the System 36s at Taylor Medical (“within 6 months”).
 - There is no plan for PC LANs to replace the mainframes they are “front ending” at GE Capital or United Airlines. (However, once again, the offloading of functions could be used as a means of controlling mainframe growth.)

- While HP client/server systems have not yet replaced any mainframe systems in the case study companies, they are scheduled to do so in three of the four companies in which they are being used as downsizing platforms. (HP appears to be doing very well in the downsizing arena—probably as a result of being an early convert to RISC technology.)
- Motorola has a highly publicized plan to replace its mainframe computers (including 4381s) with client/server networks based on its own RISC/UNIX MS 8000 systems. A definite plan for downsizing IS budgets has been established; the sale of a 4381 is scheduled to be completed this year.
- The “other” downsizing platforms are not currently scheduled to replace their target systems:
 - The Batesville Casket Co. has decided that it will downsize to “UNIX-Servers” but still may have to outsource some of its IBM 4381 work load, and it does not have a definite replacement plan. (This information was gathered from an article entitled, “IS managers admit downsizing fears” [11]; which, curiously enough, was an outgrowth of the recent Downsizing Expo. Perhaps the downsizing bloom is already off the rose.)
 - While Merrill Lynch is enthusiastic about RISC and UNIX, and is currently installing a lot of Sun client/server workstations, when asked when it might replace its IBM mainframes the answer was essentially: “never.”

In these case studies, the AS/400 is a clear winner in achieving actual replacement of mainframe systems. It is probable that any system selling at a rate of over \$1 billion a month will show up rather well in practically all market segments, but when one considers the “handicaps” this IBM orphan has had to overcome, it is indeed quite a remarkable performance. Consider the following:

- The AS/400 is a proprietary system in what is being billed as an open systems world, and it is gaining market share.
- The AS/400 architecture builds more function into hardware when the latest architectural trend is to build stripped-down RISC engines and leave the problems to systems programmers.
- The AS/400 has been virtually ignored by the trade press, consultants, and competitors throughout much of its life.
- In fact, the AS/400 has been ignored (and misunderstood) by the large systems advocates, PC advocates and RISC advocates within IBM.

- IBM has been slow to actively promote the AS/400 as a distributed data base server (for which it is so well suited)—much less as a downsizing platform to offload (or replace) mainframes.

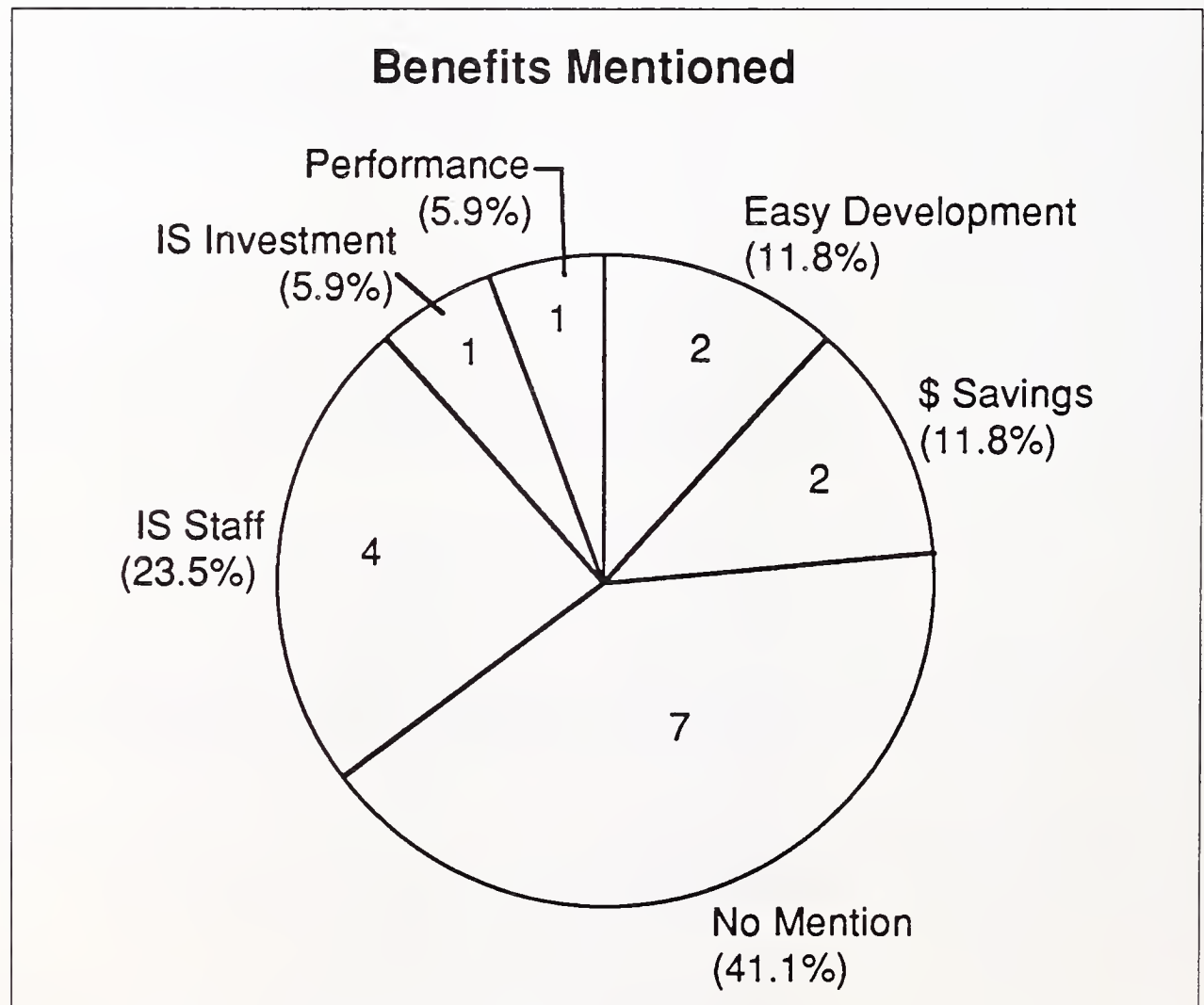
However, it is getting increasingly difficult to hide the success of the AS/400, and now *Business Week* is saying that maybe IBM will become known “as the AS/400 company and not the one that makes mainframes and PCs.” [21] The AS/400 certainly cannot be ignored as a downsizing platform, and this research confirms that opinion.

As mentioned previously, INPUT research disclosed that reduced IS and hardware costs are ranked highest among the factors prompting downsizing. Let’s see what the published case study companies have to say about the cost benefits of downsizing.

3. Cost Benefits of Downsizing

The most prevalent comment the case study companies have to say about the cost benefits of downsizing is...nothing! Exhibit V-4 shows that seven of the seventeen companies have nothing to say about cost savings, and it can only be concluded that there haven’t been any, because any IS executive who is saving his company money these days is going to be more than willing to brag about it in the press.

EXHIBIT V-4



A more detailed look at the individual companies reveals the following:

- The seven companies (41%) that did not mention cost benefits are as follows:
 - Revlon is on a crash program to migrate its IBM 3090 mainframe to an HP client/server architecture in two years. It is outsourcing its mainframe processing to Arthur Andersen, and cost benefits anticipated from this downsizing effort were not announced. However, the crash program is being undertaken because the President of Revlon North America did not want to get involved in a “five-year deal”—which indicates he has some sensitivity to the transition costs of such a radical architectural change. There is no question that a substantial initial investment will be required.
 - Georgia-Pacific, which replaced obsolete IBM 4300 midrange systems with AS/400s, will not even talk about the cost of the transition. The costs were said to be “secret.” This makes the important point that replacing obsolete systems with new technology usually requires additional investment regardless of whether the systems are being downsized to more cost-effective platforms.
 - GTE also failed to mention any cost benefits associated with the replacement of its Honeywell mainframe with a network of HP UNIX systems. It is probable that the payback here will be in controlling the growth of the IBM mainframes that will remain, and that the additional investment will be recovered over the long run.
 - GE Capital Corporation does not intend to replace its IBM 3090 but will downsize (offload) some processing to “PC front ends.” Companies that really understand information system costs seldom make snap judgements about cost benefits from new technologies. GE does understand the complexity of shifting IS costs, and it brought some realism to the Downsizing Expo by not making any outrageous claims for what it is doing.
 - United Airlines is similar to GE. It is a knowledgeable company that is taking advantage of new technology in the normal course of business. It will not get caught up in the hoopla of new technology for technology’s sake, and it is too experienced to believe that MIPS ratings or ease of use drop directly to the bottom line of information systems costs. It is careful about cost control (it is installing Phillips diskless workstations), but it is not making extravagant claims about benefits.

- Holiday Inn is installing a UNIX-based network (probably incorporating HP client/servers) that will cost approximately \$60 million. It will handle front-desk applications and reservations, and it is designed to provide competitive advantage by giving customers better service. Mainframes are not scheduled to disappear, and Holiday Inn isn't claiming any specific cost benefits.
- Haggar Apparel Co. is planning to replace an IBM 3090 computer with AS/400s within 18 months, but it isn't making any claims about the cost benefits except to state that its current systems were aging and that the availability and quality of packaged software to integrate and manage the conversion of its "wide array of existing home grown applications" swung it to the AS/400 rather than going with UNIX-based software for the RISC System/6000.
- Four companies said that reduction in IS staff was a cost benefit associated with downsizing. We will not dispute that it is possible to reduce the central IS staff by downsizing to smaller, more cost-effective systems. However, we do caution that such numbers can be misleading when user organizations are being empowered with responsibility for their own information systems. The ledger of finance may show decreased IS budgets, but the actual expense of information systems activities may be increasing. However, even if we accept the IS staff reductions at face value, examination of the individual cases raises some additional questions.
 - Corporate Headquarters of TRW has some rather impressive numbers as a result of replacing its IBM 4381 with client/server PC networks and "midrange computers." (INPUT credited this replacement to PC networks, but we suspect the midrange computers may be AS/400s.)
 - The IS department was slashed from 135 people to 50—a reduction of 63%.
 - The corporate IS budget was reduced from \$17 million to \$7 million—a reduction of 59%.
 - The cost of managing human resources, which at one time reached \$2.5 million per year, is now only \$300,000—a reduction of 88%. (This is a suspect number that probably has more to do with accounting for application development/acquisition and maintenance than it does with operational costs.)
 - And, it is projected that the cost of preparing a paycheck will drop from \$1.20 to 50 or 60 cents by the end of this year.
 - Generally speaking, these numbers (except as noted) are not terribly surprising. The 4381 is a prime target for downsizing.

- Dakin, Inc. saw its sales drop from \$200 million to \$75 million and managed to decrease its IS staff from 32 to 12 (a reduction of 62%) by replacing a Unisys V series mainframe with an IBM AS/400 with off-the-shelf financial software. Under the circumstances, we do not find the staff reduction surprising except that the percentage reduction is practically identical to those reported by TRW for a much larger IS organization (see above), and it is also directly proportional to the drop in Dakin's sales.
- At Batesville Casket Company, putting the responsibility for ad hoc reports out in the end-user departments freed up four of the 35 IS department employees (an 11% reduction) for other work. Though this will not result in actual cost savings, it is viewed by the IS department as "getting four guys for free"—so INPUT included it as a benefit of downsizing functions from the mainframe to the desktop. Batesville can be credited with a succinct summary of the alternatives for 4381 users: "We'll either learn to downsize or we'll outsource."
- Breuners (a home furnishing chain) has reduced its central IS staff from 47 to 32 (a 32% reduction), even before its 4381 has been replaced. However, this has not been an easy transition, and all of the staff reductions have not necessarily been desirable. Breuners is still in the process of re-engineering its mainframe applications by rewriting them in C for an HP client/server network. This shift was mandated by the president of the company (who happens to be a recent Harvard Business School graduate) despite the fact that substantial "up front costs are being incurred." Among the personnel impacts are the following:
 - A \$1,000 to \$2,000 "investment" per programmer to train them in the new technology (this figure probably does not include lowered programmer productivity during the transition).
 - While only a few IS employees quit because of the transition, one was the DB2 data base administrator (this could be considered either positive or negative, depending upon one's perspective).
 - Some of the newly trained C (UNIX) programmers have already left the company for "opportunities" in other organizations.
 - The migration began two years ago and still isn't complete, yet it is stated that the "speed of Breuners' shift into downsizing has stunned some observers."

- Perhaps most significant is the observation of Breuners' president that the "patchwork of code" that had evolved on the 4381 was "determining how the business was run, rather than the other way around." When all is said and done, one doesn't have to worry too much about cost/benefit analysis when the re-engineering of obsolete applications is the most important factor to management.
- Only two of the seventeen companies mentioned actual cost savings from their downsizing efforts, and the figures were, at best, vague. For example:
 - At Merrill Lynch, one "high-powered trading unit" cited reduced "computing cycle costs" from \$2 million a year down to less than \$1 million, and indicated that "This is the flavor of what gains will be realized with UNIX." There seems to be considerable confusion here about the role of hardware, systems software, applications, and mainframe billing algorithms in determining how much one pays for "computing cycles." In addition, it isn't as if mainframes are going to disappear—Merrill Lynch will retain eight IBM mainframes in two data centers to serve as super data base servers, and to handle "the heavy duty processing of month-end statements and high volume transactions." No statement is made concerning the overall cost of the information technology infrastructure, which has unquestionably gone up with the investment in expensive (though powerful) workstations, and there are indications that downsizing at Merrill Lynch was prompted primarily by the desire to give user departments applications control so they won't have to "depend on the systems group."
 - Then there is the recent case of the Orange County, Florida Appraisers Office, which states that it has already "cut some \$800,000 out of \$1.8 million of operating and maintenance costs (a 44% reduction) even before it replaced the IBM 4381 with a PC LAN network. After the 4381 is removed, it is estimated another \$400,000 will be saved for a total operating and maintenance cost reduction of 67%. It is probable that some creative and speculative accounting is being done here, but this case does emphasize the vulnerability of the low end of the IBM mainframe line. Consider the following:
 - Fourteen of the 19 nodes in the upsizing case study presented earlier (Exhibit III-2) achieved operating and maintenance cost savings exceeding 44%, which not only verifies the fact that the downsizing cost savings may be reasonable, but also demonstrates that the 4381 is vulnerable to "upsizing" as well.
 - Even the 67% cost saving figure is not entirely unreasonable, since two of the 19 nodes in the upsizing case study exceeded that figure by replacing the low end of the mainframe line with larger systems.

- Orange County also pointed out that its PC LAN network provided redundancy (servers were backed up), reliability with cheap uninterruptible power supplies, cheaper space, and cheaper DASD than the 4381—precisely the advantages identified in the upsizing case study.
- It is possible to depict downsizing and upsizing as a bell curve with PCs on the left, the 4381 at the apex, and Enterprise 9000s on the right; with the x-axis representing computer power and the y-axis representing operating and maintenance cost. (This diagram will be presented and described in more detail later in this report.)
- Two of the seventeen case study companies (Northrup King Co. and Moog Automotive) emphasized easier, faster applications development as a primary benefit of downsizing. Analysis shows that everything is relative.
 - Northrup King has already replaced a 4381 with an AS/400 and states that easier development was an added bonus in the downsizing effort.
 - Moog Automotive has downsized applications from an IBM 3081J to both AS/400 and client/server PCs (386-based PC clients, and Parallax Computer servers), and it finds that development and deployment of applications on the client/server PCs are much faster than on the AS/400. Moog stated that what would take 120 days in the AS/400 environment takes only a week on the PCs.
 - Ease of programming and use obviously depend upon both perspective and the applications being developed and/or re-engineered.
- Taylor Medical, Inc. is the only organization to emphasize improved performance of its system (in terms of turnaround time), and this downsizing effort is important from several points of view.
 - The downsizing effort was directed toward a network of System/36s that were overloaded because of company growth.
 - AS/400s, which could have provided an easy upgrade path, were ruled out because Taylor did not want to lock itself into a proprietary environment.
 - The key to success in making the shift was the conversion of RPG III applications from the System/36s to a client/server PC environment based on two SystemPro file servers, and six 33-MHz I486 DeskPros from Compaq Computer Co.

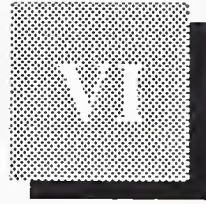
- The solution to the conversion problem was a compiler and operating environment called Baby/4XX from California Software Products, Inc. It permits Taylor Medical to run its System/36 RPG III applications on its PC network.
- The fact that turnaround time for accounts receivable has dropped from eight hours on the System/36s to 30 minutes on the new system is probably a result of replacing obsolete systems with new network technology, but the Baby/4XX software product is important because it should provide the ability to port RPG III applications from the AS/400 as well. This type of cost comparison will be of increasing importance as downsizing proceeds in the 1990s. (INPUT intends to prepare a report on downsizing methodologies as part of the downsizing program.)
- Motorola, Inc.'s General Systems Sector (GSS), which consists of two rapidly growing cellular businesses and Motorola's computer group, has set an objective of reducing IS expense to less than 1% of sales by 1993. At present, Motorola's overall IS expense is 2.8% of sales, and that of GSS is 1.4%. GSS's downsizing of the IS budget is based upon downsizing IBM mainframe applications to Motorola's own UNIX/RISC-based MS 8000s.
 - Motorola stated that one of the main reasons the objective may be met is the availability of "off-the-shelf software applications and development environments" in the UNIX world. At present, data base software from both Oracle and Informix Software is being evaluated and no date has been set for replacement of the mainframe systems.
 - Obviously a lot depends upon the quality of the off-the-shelf software Motorola is depending upon. But GSS certainly has a good shot at achieving its object of reducing its IS expense to 1% of sales—internal transfer rates can work wonders for computer companies in this regard. However, it is INPUT's observation that practically all mini-computer and PC companies still have IBM mainframes installed.
 - Motorola's arbitrary goal of reducing IS expense to less than 1% of sales reminds us that there is no significant correlation (either positive or negative) between investment in information technology and corporate performance. This obviously means that companies investing more in information technology do not necessarily obtain the "competitive advantage" promised by computer vendors. On the other hand, it is probably unreasonable to expect that reduced expenditures on information technology will drop straight to the bottom line.

Analysis of these published case studies tends to support INPUT's research in which it found that organizations with downsizing efforts actually under way did *not* consider lower IS or hardware costs to be among the most important benefits expected, even though these factors were the primary factors prompting the downsizing efforts. [2]

In addition, analysis of these "success stories" reinforces what was learned from the strategic case studies: there is currently no easy way out of the large mainframe cost trap.

However, an executive casually reading through these articles as they appear would certainly get the impression that IBM mainframes are being replaced at a prodigious rate with cheap hardware and software. Executives don't discriminate very easily among computer models, and it is understandable that a Georgia Pacific executive wouldn't realize that successfully "downsizing" 43XX systems to AS/400s isn't quite the same as replacing a 3090, Model 600. (In fact, it is possible that Georgia Pacific may have actually been "upsizing" when it installed AS/400s, but corporate executives and newspaper editors can't be expected to know that.) However, when this executive mentioned his downsizing success story in a board of directors meeting, he certainly put the VP of MIS for the railroad under considerable pressure.

There is a big credibility gap on all sides of this information technology revolution, but the fact remains that it all gets back to a question of costs: not only the relative costs of various technological "solutions," but the fundamental costs of humans versus machines in the work place. That is what downsizing is all about.



Analysis of Case Studies

The downsizing phenomenon is a manifestation of IBM's loss of control over the information technology innovation process. Specifically, the diffusion of new technology is no longer dependent upon IBM's "blessing" as it was just a few years ago. There were those, even in IBM, who intuitively knew that this day would come, but most IBM planners remained (and perhaps remain) in a state of abject denial about the vulnerability of the IBM mainframe product line. This attitude was summed up by an IBM employee interviewed by INPUT in the early 1980s. He said: "We have made a lot of money on mainframes for a long time, and there are those around here (IBM) who think it can go on forever."

IBM is still "making a lot of money on mainframes," but the end is clearly in sight. Suddenly, it seems no one is satisfied with mainframe hardware/software costs. Perhaps the end of the golden era of mainframes could have been predicted using fuzzy arithmetic and Rene Thom's concept of catastrophe [27], but it is doubtful that such a forecast would have altered IBM's business plan all that much. IBM is in the mainframe trap along with its customers. How do you gracefully adjust your business strategy from a high-margin market you dominate to a cutthroat commodity market—even if you know that change is inevitable?

The answer is you can't do it gracefully, and IBM has stumbled badly and actually contributed to the factors prompting downsizing.

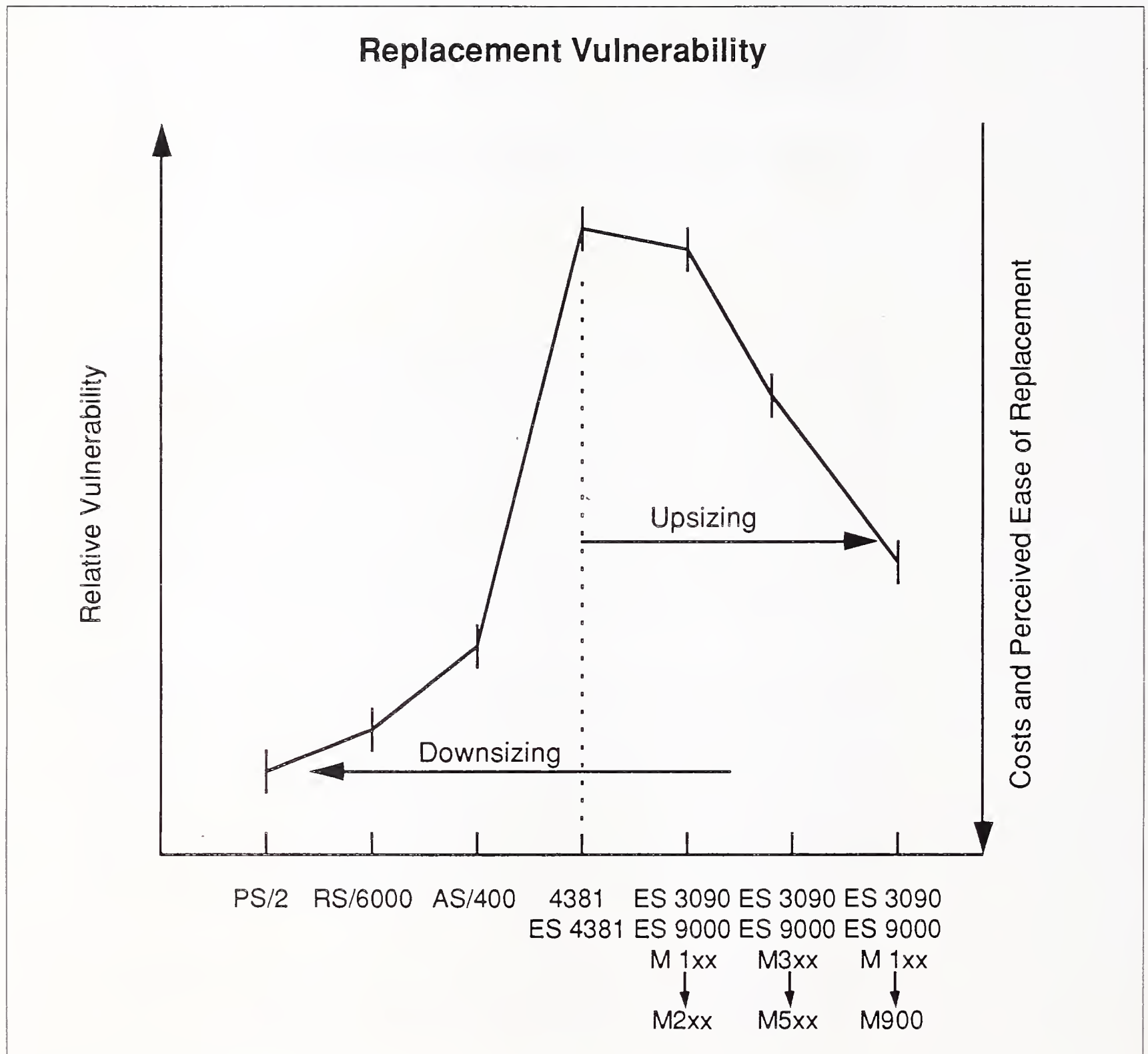
A

Factors Prompting Downsizing

The primary factors prompting downsizing are the perceived hardware/software expense and complexity of the IBM mainframe product line—especially at the low end, which stands out like a sore thumb.

INPUT was reminded of catastrophe theory when it did a chart of the relative replacement vulnerability of various IBM hardware/software platforms to both downsizing and upsizing based on analysis of the case studies in this report. (See Exhibit VI-1.)

EXHIBIT VI-1



Relative vulnerability was determined based on actual replacements, hardware/software costs, and perceived ease of replacement as demonstrated by the case studies. When this rough analytical model was completed, the IBM 4381 and smaller models of the ES 3090/9000, were positioned near what resembled a cusp (one of several elementary catastrophes) where the upsizing and downsizing curves meet. While these curves were not mathematically determined, they certainly depict a serious discontinuity in the IBM product line, and that is what catastrophe theory is all about.

The analysis supporting the chart is as follows:

- The upsizing case study at the beginning of this report demonstrated that significant cost savings can be achieved by replacing smaller mainframes and consolidating into large data centers. The cost savings associated with upsizing within the mainframe product line are based on hardware price/performance, more effective hardware/software use, fewer operating and support personnel, and less operating and environmental overhead.
- Because large mainframes are more cost effective than their smaller brothers and sisters, they are not as attractive as targets for downsizing. (In addition, application conversion problems associated with large mainframes make actual replacement difficult at best.)
- The published case studies show that 4381s and low-end 3090 mainframes are the most vulnerable to replacement through downsizing. Since these same platforms are also vulnerable to upsizing, the discontinuity in the IBM product line becomes apparent.
- The sharp drop in relative costs when downsizing low-end mainframes to minicomputers (AS/400), RISC workstations (RS/6000), and/or personal computers (PS/2) is based in large part on the same factors that make upsizing within the mainframe product line so attractive. However, there are additional perceived benefits from downsizing associated with hardware/software ease of use and application availability and/or development.
- Price/performance of personal computers also makes minicomputers and RISC workstations potentially vulnerable to downsizing.

However, the pecking order among minicomputers, RISC workstations, and personal computers (especially on the server side of the client/server architecture) has yet to be determined. Nonetheless, it is safe to state that it will be determined by factors other than raw hardware price/performance.

B

Factors Inhibiting Downsizing

There seem to be two primary factors inhibiting downsizing: 1) the number, size and complexity of installed mainframe applications and data bases; and 2) the belief on the part of IS management that all of this size and complexity is necessary (or, at least, unavoidable).

The first factor raises two questions:

- How can we convert (downsize) these applications and data bases to more cost-effective platforms? (Is downsizing possible?)
- How much will it cost to make this transition? (Is downsizing really worth it?)

As the case studies have shown, these are not always easy questions for IS management to answer.

The second factor also raises two questions:

- Are mainframe applications enabling tools (and in this we include operating systems as well as DBMSs and languages) necessary “solutions” for the development of complex mainframe applications or part of the complexity problem?
- Are the “investments” in mainframe applications and data bases corporate assets or liabilities at the present time?

These are questions that some IS managers do not really want to address or even acknowledge—it is unthinkable that everything they have worked so hard to build may be more problem than solution.

C

Architecture and Applications Selection

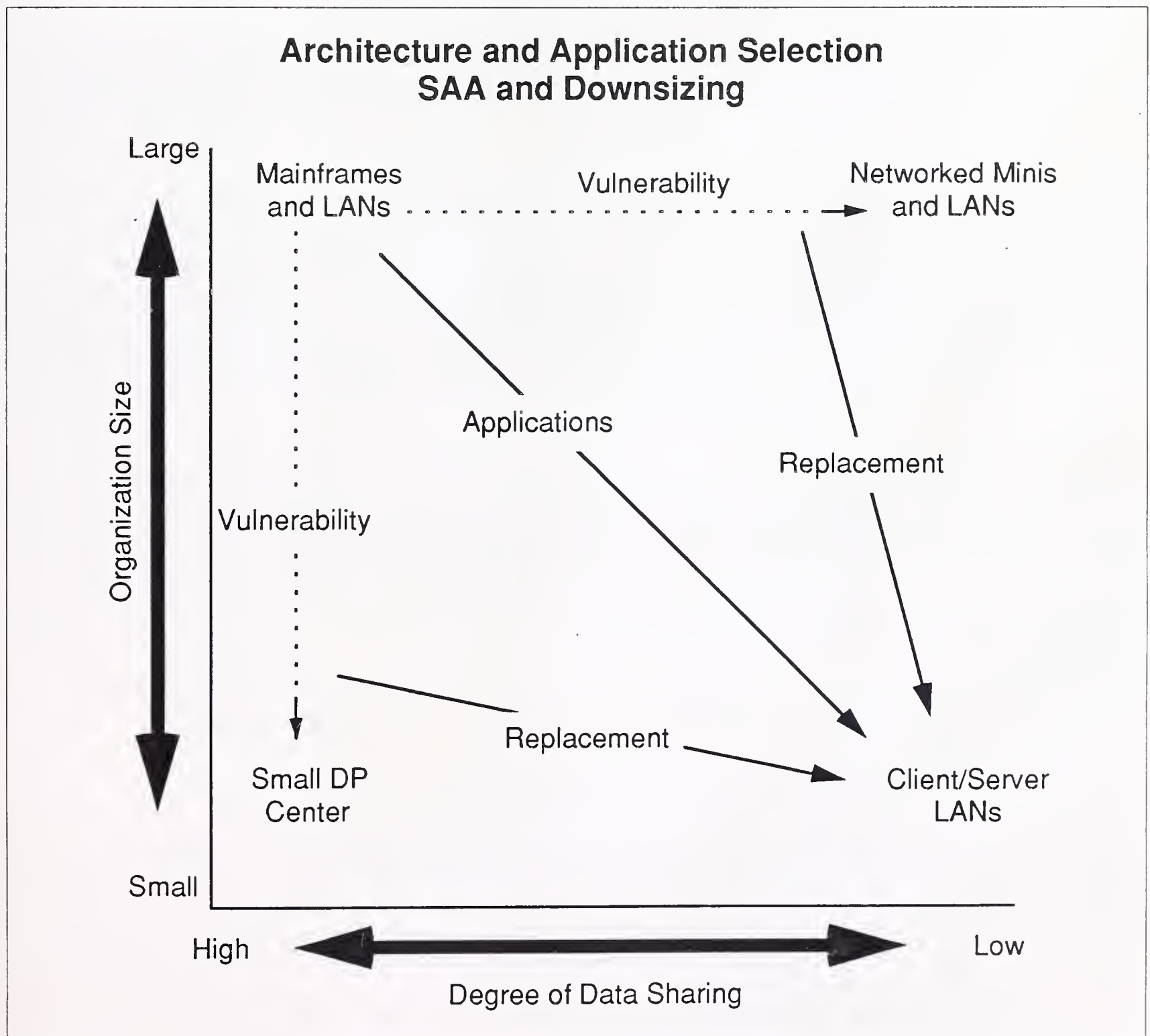
IBM's System Network Architecture (SNA) is the reason mainframes are vulnerable to downsizing. That architecture puts the mainframe at the center of the data processing universe, and IS management appears to have built a “big blue hole” that has gobbled up data from throughout the organization and made it increasingly difficult for necessary operating and management information to “escape.” That is the trap in which IS management finds itself at the present time.

1. SAA and Downsizing

IBM's Systems Application Architecture (SAA) has been described as its plan for downsizing. SAA was the direct result of customer dissatisfaction with the “big blue hole” created by SNA. It is IBM's published plan for how data and applications should be distributed over networks. By examining this plan, it is possible to determine the vulnerability of SAA to other downsizing initiatives.

INPUT has taken its view of "SAA distributed processing" from an article by that name in the *IBM Systems Journal*. [28] The article was written by Dr. Allan J. Scherr, whose experience with computer networking and multi-user systems goes back to the seminal work he did on performance measurement of timesharing systems in the 1960s. We mention this because of the importance of performance measurement (and prediction) when downsizing to client/server LANs. Dr. Scherr concludes that "distributed processing configurations" will be determined by two factors: organization size and degree of data sharing (see Exhibit VI-2).

EXHIBIT VI-2



He concludes the following:

- That client/server LANs (as we now know them) are appropriate for small organizations that require a minimum of data sharing.
- That small organizations with a high degree of data sharing are best served by a “small DP center” with nonprogrammable workstations.
- That large organizations with limited data sharing will typically have networked minicomputers and distributed data bases supporting nonprogrammable workstations either directly attached to the minis or on LANs.
- That large organizations with a high degree of data sharing will have a large “central DP complex” with mainframes and central data bases that will serve LANs (with non-programmable workstations) through remote “communication processors.”

These are obviously the extreme cases because in an earlier *IBM Systems Journal* article, Dr. Scherr made a convincing argument that mainframes, minicomputers and personal computers would all have important roles to play in most business organizations of any significant size. [29] However, the heavy emphasis upon nonprogrammable workstations in these configurations is certainly enough to raise questions about whether IBM’s view of downsizing corresponds with that of the rest of the world. Fortunately, the body of the article points out that:

“The first mode of distributed processing is local processing, where the application and data are in the same node, which is either the user’s intelligent (programmable) workstation itself or the node closest to the user’s workstation. In a well-designed distributed system, the local data processing mode is usually prevalent, because it offers the best performance and lowest cost.” [28]

So, SAA (or at least Dr. Scherr) has noble objectives: migration of both applications and data to the most cost-effective level.

2. Application and Data Placement

Dr. Scherr reached his conclusion that “a well-designed distributed system” usually places emphasis on the local data processing node based on a model for determining the proper placement of applications and data in a network. The model measures message traffic between: users and applications, applications and data bases, and application programs. Then cost data are developed showing overhead in terms of response time, cycles executed on the various processors, and communications costs to implement the message traffic. When these are used to compute the specific communication costs for various placements of programs and data, Dr. Scherr states that three “facts” emerge:

- 1) Communication within a data processing node is significantly more efficient (cheaper) than communication from node to node.
- 2) The traffic between applications and data is significantly higher than the traffic between users and applications.
- 3) The cost of communication between two processors in the same building or campus (using local-area networking facilities) is significantly lower than communication between buildings or campuses requiring wide-area networking facilities.

These “facts” lead to the conclusion that “users and the applications and data they use should, whenever possible, be placed in the same data processing node.” In other words, most applications are suitable for downsizing provided data can be distributed along with the applications programs.

Dr. Scherr thus made a convincing argument for downsizing at the time SAA was announced. He proved what most corporate executives and IS managers now intuitively “know”—large mainframes and centralized data bases are not cost effective for most applications. Thus SAA can fairly be stated to be IBM’s “plan” for downsizing. The problem has been that there is limited understanding and/or acceptance of SAA among the IBM customer base (much less the rest of the world), and progress in implementing SAA has been excruciatingly slow.

While there isn’t a great deal of talk about SAA these days, the AS/400 is emerging as a leading downsizing platform, and OS/2 2.0 has exceeded IBM’s expectations since it was introduced in March 1992. (It was recently reported that 700,000 copies of OS/2 2.0 had been shipped in the first three months of availability. [30])

a. Managing Price/Performance in a Client/Server Environment

Dr. Scherr’s model for the cost-effective distribution of programs and data in networks provides an objective basis for selecting applications to be downsized, and he implies that empirical research supports the “fact” that both programs and data should normally be kept as close to the user as possible. While this all supports the general trend toward downsizing of mainframe applications, Dr. Scherr goes on to point out that the use of multiple data processing systems within the enterprise “creates the need for system management facilities designed for a distributed environment,” and he concludes that “most enterprises will want to manage the network of systems as a single entity.”

b. Centralization versus Decentralization of Function

He then outlines the various aspects of network management that can be either centralized or decentralized depending upon the requirements of the individual enterprise. They are as follows:

1. Administration of data, data bases, security, user authorization, accounting, etc.
2. Operation of individual systems and the network itself
3. Systems programming, including the control and distribution of fixes and new versions
4. Application programming, including the control and distribution of fixes and new versions
5. Problem determination
6. Service of hardware, software and communications

The centralization of these functions frequently contributes to the favorable economics of upsizing that protect very large mainframes from replacement (see Exhibit VI-1). The determination of whether these aspects of network management should be (or remain) centralized or decentralized is at the very heart of developing a strategic downsizing plan. Most of the case study companies continue to wrestle with this problem (or problems), but one thing is certain: as downsizing proceeds the complexity of network management increases exponentially, and the need for network management tools increases accordingly.

Dr. Scherr outlines the following tools that may be necessary to maintain centralized control of emerging networks:

- A data distribution and collection facility that would schedule and track distribution of data files to any or all nodes in a network. (The tool must also be capable of collecting data files from the network.)
- A common repository for user configuration profiles, security, and addressing information that provides uniform access to data on a network-wide basis.
- A tool that allows operational personnel to monitor and control multiple systems without having to see individual screens.
- "Programmed operator" support that reduces the need for human intervention by providing preprogrammed decisions. (The ultimate objective being "lights-out" operation.)

- Problem determination facilities allowing a remote “expert” to monitor the usage of an end user who is experiencing difficulty or to work directly with a failing system.

Even when IS management is convinced that all applications can be downsized to more cost-effective platforms, it recognizes that the systems software necessary to manage increasingly complex networks is currently available only on mainframes. That is the reason few will predict when mainframes will disappear.

c. Predicting Performance

Predicting network performance is one of the most complex problems in developing a downsizing plan. Starting with the first implementation of an airline reservation system (SABRE), networks have had a disconcerting propensity to fail unexpectedly. On individual LANs this problem has typically been solved by over-engineering the network, but data sharing among nodes causes unforeseen problems.

The case study university, which has been on the leading edge of networking technology, found this out when bringing up a relatively simple image processing pilot project. Performance of the overall network was adversely impacted because of the traffic through a particular router. Even after upgrading the network backbone to 100 megabits per second, and reconfiguring Ethernet to minimize the number of hops between server and client end points, bulk file transfers remain a continuing problem for other users of the network. Current router technology does not address application-specific requirements, and per-application priority schemes to allocate bandwidth require dedication of specific workstations connected to separate networks—which defeats the purpose of networking.

Solving these problems after the fact, by either over-engineering or with new systems software, obviously alters the cost justification for downsizing. Therefore, it becomes important to be able to predict network performance before the fact.

The problems of predicting network performance are similar to, but more complex than those of predicting performance of large mainframe computers operating under complex operating systems. One of the reasons INPUT respects Dr. Scherr’s work on distributed processing is because he was one of the first to apply queuing network theory (as developed by operations research) to predict performance of central server networks (mainframes). The accuracy of the results employing these models startled computer scientists at first, but since then the models have become widely accepted as the best predictors of mainframe performance.

While progress has been made on the mathematics to extend queuing network theory to the prediction of LAN performance, the wide-area networks required by extensive use of the client/server architecture remain an unsolved technical problem.

What this all means is that prediction of hardware cost savings, when putting together a downsizing plan, is extremely difficult—regardless of how attractive those processor price/performance ratios may appear. This probably explains the fact that respondents to INPUT's original downsizing survey stated that the primary factor prompting downsizing was cost savings, but that cost savings was not one of the benefits anticipated from downsizing projects that were currently close to completion. [2] It also explains why responsible IS management is not attempting to justify downsizing on the basis of hardware cost savings alone, and few are willing to predict when, and if, their mainframes are going to disappear.

This uncertainty about network hardware savings and/or mainframe replacement carries over to the transition costs of downsizing.

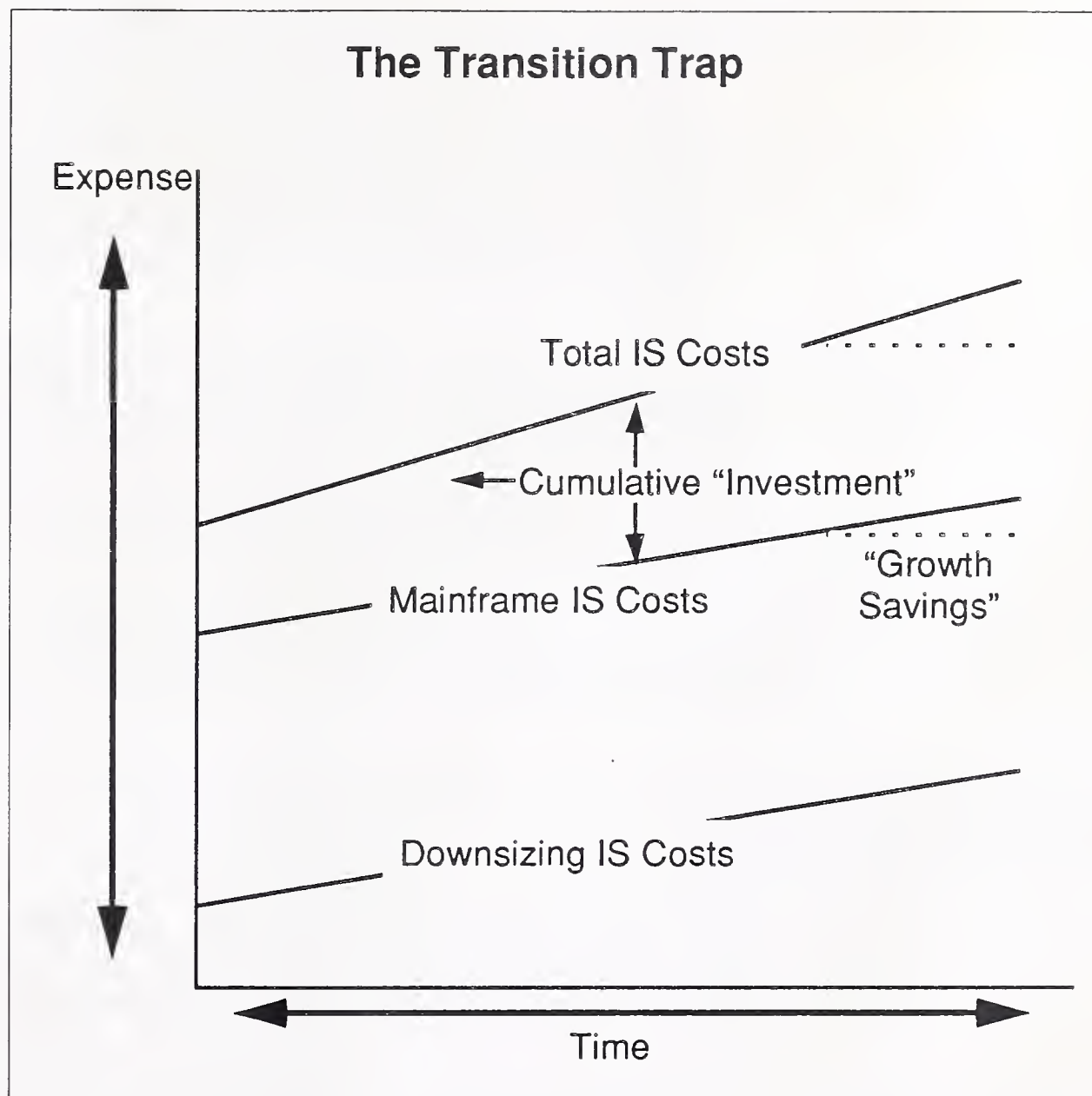
D

The Transition Trap

Everyone is in agreement that there will be substantial costs associated with any major architectural transition from a highly centralized mainframe environment to a distributed (downsized) client/server environment. Exhibit VI-3 illustrates the factors contributing to the transition trap.

- The amounts invested in downsizing hardware and the necessary conversion effort must be added to the ongoing cost of existing hardware/software systems until those systems are replaced. Therefore, the total IS cost will be higher during the transition period.
- The longer the transition period, the higher the cumulative "investment" in downsizing will become. It is of the utmost importance to complete downsizing efforts as expeditiously as possible for this reason.
- There are several unpleasant facts that frequently become evident during a downsizing transition period:
 - Downsizing individual applications usually does not result in immediate, decreased mainframe expense. While it can be demonstrated that the operating expense for the individual downsized application is less than the cost would have been to run it on the mainframe, the total cost to the organization can remain higher. (For example, the mini-computer case study company may have saved a specific end user \$90,000 on mainframe billings when it converted some applications to its UNIX-based product line, but the expense level for those mainframes will not be significantly reduced for several years.)

EXHIBIT VI-3



- Where an actual reduction in mainframe expense cannot be demonstrated, the argument is frequently made that mainframe growth has been slowed and this is claimed as a "savings." This type of "savings" is extremely difficult to quantify, and it seldom falls to the bottom line where management can see it. (Management at the railroad wants to see mainframe software expense of \$3 million go down, and it will not be impressed with arguments that additional investment in downsizing technology is necessary just to hold the line on increasing costs of software.)
- Downsizing efforts employing new hardware/software technologies will usually suffer from the traditional problems that have plagued IS management—they will exceed schedule and budget, thus prolonging the downsizing transition period and expense. (The international energy company runs the risk of complicating a relatively simple downsizing effort if it pursues the open systems option and introduces new hardware/software technology during the transition period.)

- Downsizing efforts built on a highly centralized model, such as SNA, may downsize applications and distribute data only to find that centralized network/data base management may require mainframes to grow regardless of whether they continue to actually process any end-user applications at all. (It is probable that the university is correct in assuming that it is confronted with at least two more mainframe upgrades regardless of how rapidly it attempts to move to a downsized client/server environment.)

Under the very best of circumstances, transition periods represent a time of increased information systems expense with the distinct possibility that anticipated hardware/software savings will be slow to materialize. This represents a substantial exposure to the IS department that justifies downsizing based on immediate hardware/software savings.

That is why IS management is still wrestling with the well-known challenge of justifying investment in new information technology based on reduced staffing levels.

E

Downsizing and Staffing

When corporate management talks about downsizing, it really means overall reduced staff levels. When IS management justifies information technology based on improved productivity, it really means reduced user staff levels. One of the primary factors prompting downsizing is reduced IS expense for applications development and maintenance, which really means reduced IS staff. Downsizing is all about new and improved information technology replacing white-collar personnel just as automation replaced workers on the assembly line and on the farm.

While there is some ambivalence on the part of IS management in the strategic case study companies about the impact of downsizing, there is no question that the general objective of downsizing is reduced staffing levels. (See Exhibits IV-1 and IV-3 to IV-6.) INPUT has several observations about that:

- The impact of personal computers on white-collar productivity during the 1980s was neutral at best.
- Despite the enormous investment made in information technology to support the systems development and maintenance process (hardware, applications enabling tools, aids and methodologies, etc.), there has been no demonstrable improvement in overall IS productivity over the last 30 years.

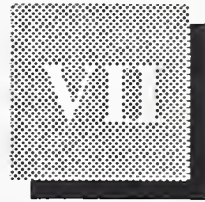
- The availability of packaged software has not generally reduced the size of IS staff in large mainframe installations.
- Any discernible improvement in white-collar productivity associated with the organizational downsizing of the 1990s seems to be more related to longer hours for the remaining white-collar workers rather than to the use of information technology.

Is there something magical about technological downsizing that will suddenly permit the improved productivity we have all been seeking for so many years? The cases studies send mixed signals in that regard.

- The medium-sized consumer products company that actually eliminated an IBM mainframe reduced IS headcount by 30%, and yet saw salary expense increase. Though INPUT has long advocated fewer, more highly skilled personnel as a means of improving productivity in the systems development process, it doubts that management anticipates increased salary expense when it downsizes headcount.
- The railroad has periodically reduced IS staff by transferring data entry and quality control to the operating department (users), only to centralize at another time as data quality problems develop. The diffusion of such data processing functions (and/or responsibility) to user personnel is characteristic of the distributed processing (client/server) environment, and every indication is that it seldom saves the company money but frequently results in an adverse impact on information systems quality.
- Four of the published case studies mention IS staff reductions as being one of the benefits of downsizing (Exhibit V-1). It is difficult to determine how much actual savings accrued to these organizations as a result of these reductions, since transfer of data processing responsibilities to clerical personnel in operating departments frequently results in upgrading of job descriptions because such personnel now must be "computer literate."

We can only conclude that there will not be a magical improvement in white-collar productivity as a result of the current downsizing trend. It is not going to solve all of the IS world's historic problems. It is merely the current solution to continuing problems most companies have faced in making effective use of rapidly changing information technology.

However, it is possible to reach other, more important conclusions about downsizing because it is a symptom of some radical changes in the information technology industry and in management mindset.



Conclusions and Recommendations

A

Conclusions

The media and corporate executives would like to believe that the raw price/performance advantages of new processor technologies will translate easily and directly into cost savings. The long history of improved computer price/performance indicates that this has seldom, if ever, been the case where commercial applications are involved. There are several reasons for this and practically all of them relate to software.

- Systems and applications enabling software designed to make computers easier to use (specifically IBM operating systems and data base management systems) have managed to consume processing cycles at least as fast as mainframe price/performance has improved.
- The development (or conversion) of applications systems to take advantage of the latest hardware/software technologies has been a slow, labor-intensive process that extends well into the next hardware cycle.
- The cost of systems and applications enabling software, originally bundled with the hardware, has increased more than enough to compensate for improved hardware price/performance.
- While this phenomenon of software costs absorbing improved hardware price/performance has been especially noticeable on mainframe computers, more recent experience with personal computers is becoming strikingly similar. It is practically as if some mysterious natural law is at work.

The phenomenon of software costs absorbing hardware price/performance “savings” before they ever hit the customer’s pocket is no longer a mystery to IS management—the force at work is IBM. IBM systems software is the driving force behind the demand for more mainframe processing power, and the customer is now paying for it doubly—for the hardware necessary to run the software and for the software itself.

Since it became apparent that even a small personal computer had enough raw power to process many commercial applications, even IBM had to come up with its own “downsizing” plan. That plan was (and perhaps still is) SAA. IBM’s inability (or unwillingness) to explain (sell) and implement that plan in a timely manner has created confusion, and even resentment, among the IBM customer base. This, in turn, has resulted in a significant loss of IBM account control.

IS management is actively pursuing downsizing and new application architectures (specifically, client/server) independent of SAA. However, while traditional IBM account control has suffered considerably during the last ten years, IBM customers now find themselves trapped on large mainframes by existing systems and applications software—to say nothing of those large centralized data bases. In order to achieve the immediate cost savings desired by management, mainframes must be replaced because merely moving applications code does not lower the cost of large mainframes appreciably.

The low end of the IBM mainframe line of computers has been vulnerable to cost-effective replacement through both upsizing and downsizing for several decades.

- Traditional economy of scale still exists in the IBM mainframe product line, but the most significant cost savings associated with upsizing from small mainframes are to be found through centralization of human resources necessary for systems, network, and data base support and management.
- The raw price/performance advantages of minicomputers, RISC processors, and personal computers have been well publicized; however, the primary cost benefits of downsizing will come from the elimination of complex and expensive systems and applications enabling software on mainframes.

Only low-end mainframes are currently being replaced by downsizing, and IS management does not see any easy way to replace high-end mainframes in the foreseeable future. In fact, it is probable that installed mainframes will continue to grow during the early phases of transition to a client/server architecture. The specific problems associated with replacing larger mainframes are:

- The enormous effort required to convert existing mainframe COBOL applications
 - Technical problems associated with maintaining data and program quality (integrity, synchronization and security) in a distributed environment

- The simple fact that large mainframes remain the only effective solution for a certain class of commercial applications with a high degree of data sharing

However, there is substantial pressure from corporate executives to downsize, and IS management recognizes that more cost-effective solutions are available for some mainframe applications. While corporate executives may be reacting to media hype, most IS managers are willing to concede that—given a clean slate—many mainframe applications could be more cost effectively implemented on downsized platforms.

Unfortunately the IS department doesn't have a clean slate, and downsizing individual applications will not normally achieve the savings desired by management. Mainframe hardware/software expense just doesn't scale down in direct proportion to the applications that are offloaded.

In addition, the promise of off-the-shelf applications software for major commercial applications remains pretty much a dream for large organizations. Even when downsizing has actually resulted in small mainframes being replaced, it has been found that conversion (transition) costs are substantial; and when going to an open environment, adding necessary skills in UNIX and C tends to inflate transition costs even further.

IS management is being placed in the difficult position of appearing to resist downsizing whenever it identifies problems associated with the radical changes of information architecture that are being proposed. However, responsible IS management must insist on detailed cost/benefit analysis if unpleasant surprises are to be avoided.

The most likely unpleasant surprise is an extended and expensive transition period during which dual hardware/software systems remain installed. Once the decision to downsize is reached, it is extremely important to get through the transition period as quickly as possible, especially if the objective is to replace the entire mainframe (as opposed to downsizing only specific applications).

The need to have tight transition schedules makes the methodology and tools employed for downsizing critical. That is the reason that *Methodologies for IT Downsizing* will be the next INPUT report in this series. However, even with the best tools available, conversion of major mainframe applications to client/server architecture can be a daunting and high-risk task—enough so that one has to question the advisability of downsizing for downsizing's sake where the primary cost justification is based on potential reduction in hardware or IS costs.

INPUT concludes that the proper justification for IT downsizing must be directly related to the contribution the new information architecture can make to business objectives. Since business objectives for most companies these days depend upon improved productivity of white-collar workers at all levels in the organization, the primary cost justification for downsizing should be the reduction of end-user staff through improved work processes. This implies significant re-engineering of current mainframe applications.

It is INPUT's conclusion that such re-engineering can be most effectively performed by in-house personnel (regardless of organizational location). Since maintenance of existing systems consumes such a high percentage of IS resources, the question becomes one of being able to free up the necessary resources to implement the downsizing project on a timely basis. Most companies will probably require the use of outside services in order to isolate the downsizing conversion team from routine maintenance of existing mainframe systems.

The relatively high fixed expense of current mainframe hardware/software as downsizing proceeds can also absorb financial resources necessary for timely implementation of the downsizing effort. It is imperative to find some way to receive immediate mainframe cost savings as applications are moved to the client/server environment. Outsourcing may be attractive in reducing mainframe cost on a timely basis.

The current highly centralized information architecture associated with mainframe systems is based on the belief that extensive data sharing among users, applications and data bases is a fact of life in the commercial environment. Therefore, complex and expensive systems software is required to manage the corporate data bases, and comprehensive distributed data base management is projected to be a universal requirement as downsizing (and SAA) proceeds. Acceptance of this hypothesis (which is essentially IBM's) gives eternal life to the mainframe superserver in most organizations, and it should be questioned by responsible IS management.

INPUT concludes that a significant number of mainframe applications can be downsized and converted to client/server using simple pair-wise connectivity and file transfer. This being the case, the primary technological battle at the server level as downsizing proceeds will be between UNIX and the proprietary OS/400. PC LANs and routers have a role to play, but they will seldom be able to break free from some type of mainframe control when major applications are being downsized.

Uncoordinated top-down downsizing of mainframe applications and uncontrolled bottom-up upsizing of personal computer applications to the client/server environment have high potential for severe integration problems and even chaos. An overall long-range plan or information architec-

ture is essential—regardless of whether the IS function is centralized, decentralized or abolished. Failure to develop such a plan, and make provision for control during transition, can militate against achieving the potential benefits of any new information architecture.

To the degree that large mainframes remain as super data base servers, it will be necessary to place some value on the centralized data bases that support the applications work being done at the working level. It is anticipated that the cost of data manipulation and management on large, general-purpose mainframes will be sufficiently high to speed the development and use of a new class of more specialized data base machines.

B

Recommendations

Consider downsizing as a part of overall network and data base management, and begin by analyzing the data and information flow of the organization. Scherr's work, briefly cited in this report, can be a good place to start in conducting such analysis (it will be reviewed in more detail in INPUT's report, *Methodologies for IT Downsizing*).

Before proceeding with downsizing, do a thorough cost/benefit analysis of current mainframe systems, with special emphasis on the value of corporate (or large mainframe) data bases. The cost factor matrix supplied in this report is a good place to start, and it should be used and refined as downsizing plans are developed and implemented.

Though it is assumed that most organizations are (or will become) familiar with advanced personal computer operating systems (OS/2 2.0, NT, etc.), IS management should also become familiar with the relative strengths and weaknesses of UNIX-based and AS/400 servers as downsizing platforms for mainframe applications. It is anticipated that proprietary and open systems will coexist in most downsized networks, and the education and training of systems personnel should begin as soon as possible.

View any small mainframe systems as good candidates for replacement either by downsizing, upsizing or outsourcing. There is seldom justification for having such systems installed.

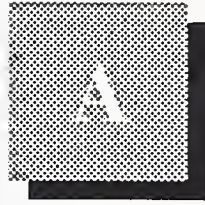
Identify and analyze mainframe single-application (or limited data sharing) systems as potential candidates for re-engineering and/or downsizing. Such dedicated mainframe systems, of any size, are costly because of mainframe systems software expense, and are usually easier to downsize than applications with complex data interdependencies. They are prime candidates for downsizing.

Carefully evaluate the availability of packaged software for the downsized application. The potential for savings is great, but so is the potential for failure if the packaged software requires companies to change their problem to fit the packaged solution.

Consider the possibility of shifting maintenance of existing mainframe systems to an outside services organization in order to free up internal systems personnel for the downsizing and/or re-engineering effort. As the information architecture becomes more in line with business needs, it is highly desirable to have knowledgeable internal personnel responsible for development, installation and maintenance.

Consider, and carefully evaluate, the possibility of outsourcing mainframe operations that are selected for downsizing. Any such outsourcing contract should have provision for scalable costs as individual applications are downsized. Outsourcing is a good way to establish benchmarks for downsizing applications and also for placing a value on centralized data bases.

Ensure that there is broad management acceptance and responsibility for the planning, implementation, and management of the resulting information architecture. If downsizing is approached with an "us" and "them" attitude on the part of either IS or the user community, it will be doomed to failure. Properly organized and managed, the downsizing effort can serve as a catalyst for the effective use of information technology to support business objectives; current mainframe systems clearly demonstrate that this is too important an issue to be entrusted to any vendor.



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